

J. W. Brown

1953-54
THE GRADUATE SCHOOL
NORTH CAROLINA STATE COLLEGE

STATE COLLEGE RECORD

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THE GRADUATE SCHOOL CATALOG

1953 - 1954

NORTH CAROLINA STATE COLLEGE

RALEIGH, NORTH CAROLINA

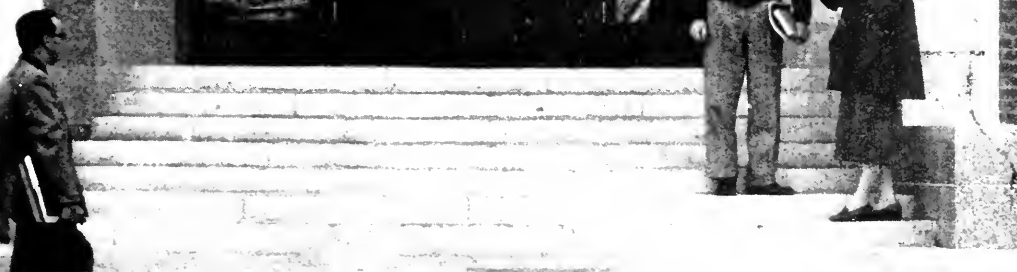


Memorial Tower



WILLIAMS HALL

DA GRONOMY M





Mechanical Engineering



Gardner Hall
Biological Sciences

WITHERS HALL



William Neal Reynolds Coliseum

THE GRADUATE SCHOOL CATALOG

1953-1954

NORTH CAROLINA STATE COLLEGE

RALEIGH, NORTH CAROLINA

*THE COLLEGE CALENDAR

1953

September 16	College Faculty Meeting.
September 18	Registration of freshmen.
September 21-22	Registration of upperclassmen and graduate students.
September 23	Class work begins.
September 30	Last day for registration and for changes in registration.
October 3	Anniversary Day (not a holiday).
October 17	<i>Last date for taking the qualifying examination for students expecting to receive the doctor's degree at the June commencement.</i>
October 30	Mid-term reports due.
November 26-29	Thanksgiving Holiday.
December 12	Final examinations begin.
December 17	Term ends. <i>Last date for taking language examinations and for filing application for admission to candidacy for students expecting to complete requirements for the Master of Science degree at the end of the winter term.</i>

1954

January 4	Registration of undergraduate and graduate students.
January 5	Class work begins.
January 12	Last day for registration or changes in registration.
February 5	Mid-term reports due.
March 12	Final examinations begin.
March 17	Term ends. <i>Last day for taking language examinations and for filing application for admission to candidacy for students expecting to complete requirements for the Master of Science degree in June.</i>
March 23	Registration of undergraduate and graduate students.
March 24	Class work begins.
March 30	Last day for registration and changes in registration.
May 6	<i>Last date for accepting theses for candidates expecting degrees at the June commencement.</i>
May 24	Last day for taking final examinations for candidates for the Master's degree at the June commencement.
May 31	Last day for taking final oral examinations for candidates for the Ph.D. degree.
June 4	Term ends.
June 6	Commencement exercises.

* Applications for admission to the Graduate School, accompanied by full credentials in the form of transcripts of academic records, should be filed in the office of the Associate Dean at least thirty days in advance of the quarter in which admission is sought.

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Henry Ames Rutherford, M.A., Head, Department of Textile Chemistry and Dyeing
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The Executive Council is made up of the members of the Advisory Boards of each of the three units of the Consolidated University. The President, the Vice-Presidents, the Chancellors and the Graduate Deans are ex-officio members of the Executive Council.

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* Resigned January 1953.

** Retired June 1953.

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Charles E. Prall, Ph.D., Professor of Education

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at

NORTH CAROLINA STATE COLLEGE

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Ph.D., University of Minnesota.
Donald Benton Anderson, Professor of Botany and Head of Division of Biological Sciences. Associate Dean of the Graduate School.
Ph.D., Ohio State University.
Richard Loree Anderson, Professor of Experimental Statistics.
Ph.D., Iowa State College.
Roy Nels Anderson, Professor of Education, Head Department of Occupational Information and Guidance and Director of Student Personnel.
Ph.D., Columbia University.
Clarence Monroe Asbill, Jr., Professor of Textile Machine Design and Development.
B.S., Clemson College.
Leonard William Aurand, Research Assistant Professor of Animal Industry.
Ph.D., Pennsylvania State College.
Willard Farrington Babcock, Professor of Civil Engineering.
S.M., Massachusetts Institute of Technology.
Ernest Ball, Associate Professor of Botany.
Ph.D., University of California.
Warren Sandusky Barham, Research Associate Professor of Horticulture.
Ph.D., Cornell University.
Frederick Schenck Barkalow, Jr., Professor of Zoology and Head of Zoology Faculty.
Ph.D., University of Michigan.

*Membership in the graduate faculty may be in either of two categories: (1) Full status or (2) Provisional status. Full status permits a faculty member to engage in any and all phases of the graduate programs of the college. Provisional members may teach courses at the graduate level and participate in the planning of graduate student programs. They may not serve as chairmen of advisory committees or assume responsibility for the direction of the research studies of graduate students.

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Ph.D., University of North Carolina.
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Ph.D., Purdue University.
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Ph.D., University of Michigan.
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Ph.D., University of North Carolina.
- William Callum Bell, Research Professor of Ceramic Engineering in Engineering Research.
Ph.D., Ohio State University.
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D.F., Duke University.
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M.Sc., University of Kentucky.
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B.T.E., Lowell Textile Institute.
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Ph.D., University of Pittsburgh.
- Charles Raymond Bramer, Professor of Civil Engineering.
E.M., Michigan College of Mining and Technology.
- Bartholomew Brandner Brandt, Professor of Zoology.
Ph.D., Duke University.
- Cornelius Godfrey Brennecke, Professor of Electrical Engineering and Head of Department.
Ph.D., New York University.
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Ph.D., Kansas State College.
- Richard Bright, Associate Professor of Chemical Engineering.
M.S., State University of Iowa.
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S. D., Carnegie Institute of Technology.
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Ph.D., University of Chicago.
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B.S., Clemson College.
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- Victor Stuart Carson, Professor of Electrical Engineering.
Ph.D., Leland Stanford University.
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M.S., Michigan State College.
- Robert Barnes Casady, Assistant Professor of Animal Industry.
Ph.D., University of California.

* On leave 1953-54.

- John Wesley Cell, Professor of Mathematics.
Ph.D., University of Illinois.
- Douglas Scales Chamblee, Assistant Professor of Agronomy.
Ph.D., Iowa State College.
- William Von Chandler, Research Assistant Professor of Agronomy.
M.S., Alabama Polytechnic Institute.
- John Montgomery Clarkson, Professor of Mathematics.
Ph.D., Cornell University.
- Carlyle Newton Clayton, Professor of Plant Pathology.
Ph.D., University of Wisconsin.
- Fred Deward Cochran, Professor of Horticulture.
Ph.D., University of California.
- Nathaniel Terry Coleman, Associate Professor of Agronomy.
Ph.D., N. C. State College.
- Dean Wallace Colvard, Head of Department and Professor of Animal Industry.
Ph.D., Purdue University.
- William Earle Colwell, Professor of Agronomy, Head of Department.
Ph.D., Cornell University.
- Ralph Ernest Comstock, Professor of Experimental Statistics.
Ph.D., University of Minnesota.
- Norval White Conner, Professor of Mechanical Engineering.
M.S., Iowa State College.
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M.S., N. C. State College.
- Harold Maxwell Corter, Associate Professor of Psychology, Director of Psychological Clinic.
Ph.D., Pennsylvania State College.
- Walter Patton Cotton, Associate Professor of Agricultural Economics.
Ph.D., University of Minnesota.
- Benjamin Franklin Cox, Associate Professor of Poultry Science.
D.V.M., Alabama Polytechnic Institute.
- Gertrude Mary Cox, Professor of Experimental Statistics Director, Institute of Statistics.
M.S., Iowa State College.
- Ralph Waldo Cummings, Professor of Agronomy Director of Research, Agricultural Experiment Station.
Ph.D., Ohio State University.
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M.S., N. C. State College.
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Ph.D., University of Wisconsin.
- Jesse Seymour Doolittle, Professor of Mechanical Engineering.
M.S., Pennsylvania State College.
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D.Eng., Yale University.
- Preston William Edsall, Professor of History and Political Science and Head of Department.
Ph.D., Princeton University.
- Don Edwin Ellis, Professor of Plant Pathology.
Ph.D., University of North Carolina.
- John Lincoln Etchells, Professor of Animal Industry, Botany, and Horticulture.
Ph.D., Michigan State College.

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Ph.D. Rutgers University.
- John Lawrence Evers, Associate Professor of Zoology.
Ph.D., University of Texas.
- Ralph Eigil Fadum, Professor of Civil Engineering, Head of Department.
S.D., Harvard University.
- Ivan, Yen-Ta Feng, Visiting Associate Professor, School of Textiles.
M.S., N. C. State College.
- Alva Leroy Finkner, Associate Professor of Experimental Statistics.
Ph.D., N. C. State College.
- Hilbert Adam Fisher, Professor of Mathematics, Head of Department.
M.S., N. C. State College; L.L.D., Lenoir Rhyne.
- James Walter Fitts, Professor of Agronomy.
Ph.D., Iowa State College.
- Garnet Wolsey Forster, Professor of Agricultural Economics.
Ph.D., University of Wisconsin.
- Rudolf Ernst Freund, Associate Professor of Economics and Agricultural Economics.
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Ph.D., Iowa State College.
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B.S., Virginia Polytechnic Institute.
- Wilhelm F. Gauster, Professor of Electrical Engineering.
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- George Wallace Giles, Head of Department and Professor of Agricultural Engineering.
M.S., University of Missouri.
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Ph.D., University of Maryland.
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- Lemuel Goode, Assistant Professor of Animal Industry.
M.S., University of West Virginia.
- Walton Carlyle Gregory, Professor of Agronomy.
Ph.D., University of Virginia.
- Henry Edwin Grisct, Associate Professor of Civil Engineering.
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- Daniel Swartwood Grosch, Associate Professor of Genetics.
Ph.D., University of Pennsylvania.
- Elliot Brown Grover, Abel C. Lineberger Professor of Yarn Manufacturing;
Head, Department of Yarn Manufacturing, School of Textiles.
B.S., Massachusetts Institute of Technology.
- George Albert Gullette, Professor of Social Studies and Head of Department.
Ph.D., University of Michigan.
- Robert John Hader, Associate Professor of Experimental Statistics.
Ph.D., North Carolina State College.
- Nathan Scott Hall, Professor of Agronomy.
Ph.D., University of North Carolina.
- Dame Scott Hamby, Associate Professor of Textiles.
B.S., Alabama Polytechnic Institute.

- Charles Horace Hamilton, Head of Department and Professor of Rural Sociology.
Ph.D., University of North Carolina.
- Karl P. Hanson, Professor of Mechanical Engineering and Head of Department.
M.S., University of Michigan.
- Reinard Harkema, Professor of Zoology.
Ph.D., Duke University.
- Thomas Roy Hart, Director of Instruction, School of Textiles.
M.S., N. C. State College.
- Lodwick Charles Hartley, Professor of English and Head of Department.
Ph.D., Princeton University.
- Paul H. Harvey, Research Professor of Agronomy.
Ph.D., Iowa State College.
- Francis Jefferson Hassler, Research Associate Professor of Agricultural Engineering.
Ph.D., Michigan State College.
- Arthur Courtney Hayes, Associate Professor of Textile Chemistry and Dyeing.
M.S., N. C. State College.
- Russell Frank Hazelton, Associate Professor of Chemical Engineering.
Ph.D., University of Michigan.
- Teddy Theodore Hebert, Assistant Professor of Plant Pathology.
Ph.D., N. C. State College.
- *James Harold Hilton, Professor of Animal Industry; Dean of Agriculture.
D.Sc., Purdue University.
- Thomas I. Hines, Professor of Industrial and Rural Recreation and Head of Department.
M.A., University of North Carolina.
- Lawrence Earle Hinkle, Professor of Modern Languages and Head of Department.
D.SesL., Dijon University.
- George Burnham Hoadley, Professor of Electrical Engineering.
D.Sc., Massachusetts Institute of Technology.
- Elmer George Hoefler, Professor of Mechanical Engineering.
M.E., University of Wisconsin.
- Adolf Hoermann, Special Lecturer in Diesel Engineering.
M.S., Institute of Technology, Munich.
- Earl Henry Hostetler, Professor of Animal Industry; Head, Animal Husbandry Section.
M.S., N. C. State College.
- Ivan Hostetler, Professor of Industrial Arts Education and Head of Department.
Ed.D., University of Missouri.
- Herman Brooks James, Professor of Agricultural Economics and Head of Department.
Ph.D., Duke University.
- Charles Warren Jennings, Associate Professor of Chemistry.
Ph.D., Duke University.
- James Herbert Jensen, Reynolds Professor of Plant Pathology and Head of Plant Pathology Faculty.
Ph.D., University of Wisconsin.

* Resigned June 1953.

- Ivan Dunlavy Jones, Professor of Horticulture.
Ph.D., University of Minnesota.
- Joseph Wheeler Kelly, Associate Professor of Poultry Science.
Ph.D., Iowa State College.
- Arthur Kelman, Assistant Professor of Plant Pathology.
Ph.D., N. C. State College.
- Richard Adams King, Associate Professor of Agricultural Economics.
A.M., Harvard University.
- James Herbert Jensen, Reynolds Professor of Plant Pathology and Head of Plant Pathology Faculty.
Ph.D., Ohio State University.
- Glenn Charles Klingman, Associate Professor of Agronomy.
Ph.D., Rutgers University.
- William Wurth Kriegel, Professor of Ceramic Engineering, Head of Department.
Dr.Ing., Technische Hochschule, Hanover, Germany.
- Walter Michael Kulash, Associate Professor of Zoology.
Ph.D., Massachusetts State College.
- Arthur Irish Ladu, Professor of English.
Ph.D., University of North Carolina.
- John Harold Lampe, Dean of the School of Engineering.
Dr.Eng., Johns Hopkins University.
- Forrest Wesley Lancaster, Professor of Physics.
Ph.D., Duke University.
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Ph.D., Indiana University.
- James Edward Legates, Research Assistant Professor of Animal Industry.
Ph.D., Iowa State College.
- Samuel George Lehman, Professor of Plant Pathology.
Ph.D., Washington University.
- Jack Levine, Professor of Mathematics.
Ph.D., Princeton University.
- Paul E. Lewis, Associate Professor of Mathematics.
Ph.D., University of Illinois.
- Clarence Earl Libby, Professor of Pulp and Paper Technology.
Ch.E., University of Maine.
- Richard Henry Loeppert, Associate Professor of Chemistry.
Ph.D., University of Minnesota.
- Wreal Lester Lott, Professor of Chemistry.
Ph.D., Cornell University.
- George Blanchard Lucas, Research Assistant Professor of Plant Pathology.
Ph.D., Louisiana State University.
- Henry Lawrence Lucas, Jr., Professor of Experimental Statistics.
Ph.D., Cornell University.
- James Fulton Lutz, Professor of Agronomy.
Ph.D., University of Missouri.
- Joseph Thomas Lynn, Assistant Professor of Physics.
M.S., Ohio State University.
- Clayton Doyle McAuliffe, Associate Professor of Agronomy.
Ph.D., Cornell University.
- Stanley Bert McCaleb, Research Assistant Professor of Agronomy.
Ph.D., Cornell University.
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M.S. in C.E., Purdue University.

- Edgar Warren McElwee, Research Associate Professor of Horticulture.
Ph.D., Ohio State University.
- William McGehee, Visiting Professor of Psychology.
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Ph.D., Harvard University.
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Ph.D., University of North Carolina.
- T. Ewald Maki, Professor of Forest Management.
Ph.D., University of Minnesota.
- Thurston Jefferson Mann, Assistant Professor of Agronomy.
Ph.D., Cornell University.
- Lee Roy Martin, Associate Professor of Agricultural Economics.
Ph.D., Harvard University.
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Ph.D., N. C. State College.
- Selz Cabot Mayo, Associate Professor of Rural Sociology.
Ph.D., University of North Carolina.
- Jefferson Sullivan Meares, Professor of Physics.
M.S., N. C. State College.
- Adolph Mehlich, Research Associate Professor of Agronomy.
Ph.D., University of Wisconsin.
- Arthur Clayton Menius, Jr., Professor of Physics.
Ph.D., University of North Carolina.
- Zeno Payne Metcalf, Professor of Zoology and Entomology.
D.Sc., Harvard University.
- Gordon Kennedy Middleton, Professor of Agronomy.
Ph.D., Cornell University.
- Eilif V. Miller, Associate Professor of Agronomy.
Ph.D., Cornell University.
- Philip Arthur Miller, Associate Professor of Agronomy.
Ph.D., Iowa State.
- William Dykstra Miller, Associate Professor of Forestry.
Ph.D., Yale University.
- Adolphus Mitchell, Professor of Engineering Mechanics.
M.S., University of North Carolina.
- Theodore Bertis Mitchell, Professor of Entomology.
D.S., Harvard University.
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Ph.D., Pennsylvania State College.
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Ph.D., N. C. State College.
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M.S., University of California.
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Ph.D., University of Tennessee.
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Ph.D., University of North Carolina.
- Werner Lind Nelson, Professor of Agronomy.
Ph.D., Ohio State University.
- Nelson Leonard Nemerow, Assistant Professor of Civil Engineering.
Ph.D., Rutgers University.
- Charles S. Nevin, Assistant Professor of Chemistry.
Ph.D., Pennsylvania State College.

* Resigned December 1952.

- Lowell Wendell Nielsen, Associate Professor of Plant Pathology.
Ph.D., Cornell University.
- Charles Joseph Nusbaum, Professor of Plant Pathology.
Ph.D., University of Wisconsin.
- *Felix Alexander Nylund, Associate Professor of Agricultural Education.
Ph.D., Cornell University.
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Ph.D., The University of Stockholm, Sweden.
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D.V.M., Michigan State College.
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Ph.D., University of North Carolina.
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Ph.D., Cornell University.
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Ph.D., University of Iowa.
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Ph.D., University of Minnesota.
- Robert McLean Pinkerton, Professor of Mechanical Engineering.
B.Sc., Bradley University.
- Joseph Alexander Porter, Jr., Associate Professor of Textiles.
M.S., North Carolina State College.
- John Clarkson Potter, Assistant Professor of Chemistry.
Ph.D., Duke University.
- Richard Joseph Preston, Dean of the School of Forestry.
Ph.D., University of Michigan.
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Ph.D., N. C. State College.
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Ph.D., University of Wisconsin.
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M.E., Tufts College.
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Ph.D., University of Minnesota.
- Cowin Cook Robinson, Associate Professor of Chemistry.
Ph.D., University of Wisconsin.
- Harold Frank Robinson, Professor of Experimental Statistics.
Ph.D., Nebraska University.
- Charles Victor Rue, Assistant Professor of Ceramic Engineering.
M.S. in Cer.E., N. C. State College.
- Paul James Rust, Assistant Professor of Psychology and English.
Ph.D., University of Washington.
- Henry Ames Rutherford, Head, Department of Textile Chemistry and Dyeing.
M.A., George Washington University.
- George Howard Satterfield, Professor of Chemistry.
M.A., Duke University.
- Clarence Cayce Scarborough, Professor in Agricultural Education and Head of Department.
Ed.D., University of Illinois.

* On leave 1953-54.

- Marshall Langdon Schmitt, Associate Professor of Industrial Arts Education.
M.S., Ohio State University.
- George William Schneider, Research Associate Professor of Horticulture.
Ph.D., Rutgers University.
- Edward Martin Schoenborn, Jr., Professor of Chemical Engineering, Head of Department.
Ph.D., Ohio State University.
- Herbert Temple Scofield, Professor of Botany and Head of Botany Faculty.
Ph.D., Cornell University.
- John Frank Seely, Assistant Professor of Chemical Engineering.
M.S., North Carolina State College.
- Weldon Owen Shepherd, Acting Chief, Range Research in Cooperation with Animal Industry.
Ph.D., University of Nebraska.
- Francis Webber Sherwood, Professor of Animal Industry.
Ph.D., Cornell University.
- William Edward Shinn, Chester H. Roth Professor of Knitting; Head, Knitting Department, School of Textiles.
M.S., N. C. State College.
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Ph.D., University of Iowa.
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B.Arch., Ohio State University.
- Charles Smallwood, Jr., Associate Professor of Civil Engineering.
M.S., Harvard University.
- Benjamin Warfield Smith, Associate Professor of Agronomy.
Ph.D., University of Wisconsin.
- Clyde Fuhrman Smith, Professor of Entomology and Head of Entomology Faculty.
Ph.D., Ohio State University.
- Frank Houston Smith, Research Associate Professor of Animal Industry.
M.S., N. C. State College.
- George Wallace Smith, Professor of Engineering Mechanics and Head of Department.
D.Sc., University of Michigan.
- Hugh Fairfield Smith, Professor of Experimental Statistics.
M.S.A., Cornell University.
- Rufus Hummer Snyder, Professor of Physics.
Ph.D., Ohio State University.
- Marvin Luther Speck, Associate Professor of Animal Industry.
Ph.D., Cornell University.
- Hans Heinrich Anton Stadelmaier, Research Associate Professor of Engineering Research.
M.S., Technische Hochschule, Stuttgart, Germany.
- William A. Stephen, Extension Beekeeper in Entomology.
M.A., University of Toronto, Toronto, Canada.
- Stanley G. Stephens, Reynolds Professor of Genetics and Head of Genetics Faculty.
Ph.D., Edinburgh University, Scotland.
- William Damon Stevenson, Jr., Professor of Electrical Engineering.
M.S., University of Michigan.
- Hamilton Arlo Stewart, Professor of Animal Industry.
Ph.D., University of Minnesota.

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Ph.D. University of Illinois.
- Jasper Leonidas Stuckey, Professor of Geology and Head of Department.
Ph.D., Cornell University.
- Paul Porter Sutton, Professor of Chemistry.
Ph.D., Johns Hopkins University.
- Elias Lake Tolbert, Assistant Professor of Occupational Information and Guidance.
Ed.D., Columbia University.
- Samuel B. Tove, Research Assistant Professor of Animal Industry.
Ph.D., University of Wisconsin.
- *Henry Keith Townes, Jr., Research Professor of Entomology.
Ph.D., Cornell University.
- Newton Underwood, Professor of Physics.
Ph.D., Brown University.
- Mehmet Ensar Uyanik, Associate Professor of Civil Engineering.
Ph.D., University of Illinois.
- Cornelius Henricus Maria van Bavel, Research Associate Professor of Agronomy.
Ph.D., Iowa State College.
- Arthur W. Waltner, Associate Professor of Physics.
Ph.D., University of North Carolina.
- Frederick Gail Warren, Associate Professor of Animal Industry.
Ph.D., Pennsylvania State College.
- Robert Kenneth Waugh, Professor of Animal Industry and Head of Dairy Husbandry Section.
Ph.D., Purdue University.
- Bertram Whittier Wells, Professor of Botany.
Ph.D., University of Chicago.
- Joseph Arthur Weybrew, Research Professor of Agronomy and Chemistry.
Ph.D., University of Wisconsin.
- Raymond Cyrus White, Assistant Professor of Chemistry.
Ph.D., West Virginia University.
- Larry Alston Whitford, Associate Professor of Botany.
Ph.D., Ohio State University.
- Benjamin Lincoln Whittier, Edgar and Emily Hesslein Professor of Fabric Development and Construction; Head, Department of Fabric Development and Construction, School of Textiles.
B.S., William College.
- Eugene Arthur Wilkening, Assistant Professor of Rural Sociology.
Ph.D., University of Chicago.
- Sanford Richard Winston, Professor of Sociology, Head of Department.
Ph.D., University of Minnesota.
- Lowell Sheridan Winton, Professor of Mathematics.
Ph.D., Duke University.
- George Herman Wise, Reynolds Professor of Animal Industry; Head, Animal Nutrition Section.
Ph.D., University of Minnesota.
- Willie Garland Woltz, Research Professor of Agronomy.
Ph.D., Cornell University.
- William Walton Woodhouse, Jr., Professor of Agronomy.
Ph.D., Cornell University.
- E. Travis York, Jr., Professor of Agronomy.
Ph.D., Cornell University.

* On leave 1952-1954.

THE GRADUATE SCHOOL OF THE UNIVERSITY OF NORTH CAROLINA

STATE COLLEGE DIVISION

William Whatley Pierson, Jr., Dean, Chapel Hill

Donald Benton Anderson, Associate Dean, Raleigh

ORGANIZATION

The Graduate School of the Consolidated University of North Carolina is composed of three divisions, one at each of the three units of the University System. The Consolidated Graduate School is administered by the Graduate Dean and a Graduate Council composed of representatives of each of the units of the Consolidated University. The graduate programs in each of the units of the University System are administered by an Associate Dean. At State College the Associate Dean is assisted in all matters of policy by an Administrative Board of seven members, five of whom are elected by the faculties of the degree granting schools, the remaining two being appointed by the Chancellor after consultation with the Associate Dean.

Graduate instruction at State College is organized to provide opportunity and facilities for advanced study and research in the fields of Agriculture, Engineering, Forestry, Textiles, and Technological Education. The purpose of these graduate programs is to develop in advanced students a more adequate comprehension of the scope of knowledge in these special fields of learning and an understanding of the requirements and responsibilities essential for independent research investigations. In all of the graduate programs emphasis is placed upon a high level of scholarship rather than upon the satisfaction of specific course or credit requirements.

Facilities.—The full resources of the Consolidated University of North Carolina are made available to all graduate students enrolled at any one of the three branches of the Graduate School. Exceptional facilities for graduate study are provided at State College. An extensive program of building has added ten large buildings designed for teaching and research to the physical plant. The new buildings will furnish modern well equipped laboratories for graduate study in specialized areas of Agriculture, Engineering, Forestry, and Textiles. One of the new buildings houses a nuclear reactor. Research facilities are available in the new reactor building for graduate students in physics, engineering and the biological sciences.

The North Carolina Agricultural Experiment Station and the Department of Engineering Research are integral parts of the College. The staff, research facilities, equipment, and field studies of these organizations contribute in a very important way to the graduate programs of the College. The presence of the Institute of Statistics on the State College Campus makes available to graduate students unusual opportunities in this important phase of research study.

The state of North Carolina, extending from the Atlantic Ocean westward about 500 miles to the high Appalachian Mountains, possesses an exceptional range of climatic and topographic environments. The coastal plain, the piedmont, and the mountains provide a rich pattern of agricultural and industrial activities which offer exceptional opportunity for research study and employment.

State College is located in Raleigh, a city of 65,000, situated on the boundary separating the broad coastal plains on the east from the rolling terrain of the piedmont on the west, about midway between the northern and southern boundaries of the state. Raleigh is 29 miles from Chapel Hill, the location of the University of North Carolina, and 26 miles from Durham, the home of Duke University. The libraries and other facilities of the three institutions make this area one of the important centers of research opportunity in the South.

The College Library

The N. C. State College Library has excellent holdings in materials essential for research study in the graduate curricula offered by the college.

As of July 1, 1952 the College Library held 110,135 volumes of books and bound journals, and 11,648 bound volumes of documents. The books and journals have been selected to reflect strongly the scientific and technological interests of the College, and the documents represent a most important increment of the whole collection. They include, in addition to the publications of the Federal government, all publications of the various Agricultural Experiment Stations, most of the publications of the Engineering Experiment and Engineering Research Stations, and publications of the various research stations from all over the world.

The depository status of the College Library may be described as follows:

1. The Library is a complete depository for all unclassified publications of the Federal government that are available for distribution. This includes, of course, publications of the U.S.D.A., Geological Survey, National Bureau of Standards, Department of Interior, etc. Since 1923, the year the library was designated as a depository, our document holdings in the fields of our special interest are almost 100% complete.
2. The Library is a complete depository for all publications of the Geological Society of America. The Library has a complete file of all GSA publications.
3. The Library is a "selective" depository for the publications of the Carnegie Institution of Washington. The Library has excellent files of these valuable monographs.
4. The Library is one of 41 depositories for all unclassified and declassified publications of the Atomic Energy Commission.
5. The Library receives on exchange the publications of many foreign countries—especially publications dealing with the agriculture sciences and with engineering.

The resources of the College library together with the generous assistance given to us by our sister institution, the University Library at Chapel Hill, and inter-library loan service available from other scientific libraries make the D. H. Hill Library of the North Carolina State College a highly satisfactory adjunct of the graduate program of the College.

Research Program at the Oak Ridge Institute of Nuclear Studies

North Carolina State College as a unit of the Consolidated University of North Carolina is one of the sponsoring institutions of the Oak Ridge Institute of Nuclear Studies located at Oak Ridge, Tennessee. Through

this cooperative association with the Insitute our graduate research program has at its disposal the facilities of the National Laboratories in Oak Ridge and of the research staffs of these laboratories. When Master's and Doctoral candidates have completed their resident work, it may be possible, by special arrangement, for them to go to Oak Ridge to do their research problems and prepare their theses. In addition, it is possible for the staff members of this university to go to Oak Ridge for varying periods, usually not less than three months, for advanced study in their particular fields.

Institute of Statistics

The development of the Institute of Statistics has made an important contribution to the graduate program at State College. The Institute is organized as a part of the Consolidated University of North Carolina with a Department of Experimental Statistics at State College and a Department of Mathematical Statistics at the University at Chapel Hill.

By utilizing the combined strengths of the two departments in most of its work, the Institute draws upon the excellent background of theory and the experience of application found in few institutions in the world. The instructional program is backed by an active responsibility in consulting with institutional and contract research projects and by an increasing volume of research in statistics and methodology.

THE GRADUATE DEGREES

The Graduate School of State College offers work leading to the Master of Science degree in the specialized branches of Agriculture, Education, Engineering, Forestry and Textiles; the Master's degree in Agriculture, Technological Education and Forestry; and the Doctor of Philosophy degree in certain fields of Agriculture and Engineering.

A graduate student is expected to familiarize himself with the requirements for the degree for which he is a candidate and is held responsible for the fulfillment of these requirements. This applies to the last dates on which theses may be accepted, the dates for examinations, the proper form of theses, and all other matters regarding requirements for degrees.

ADMISSION

Admission may be to full graduate standing, provisional or special. All applications for admission to the Graduate School must be accompanied by official transcripts from all colleges previously attended.

Admission to full Graduate Standing is granted to a student who has a Bachelor's degree from a recognized college or university regarded as standard by a regional or general accrediting agency, and who has an average grade of B or better in the undergraduate major.

Students admitted to full graduate standing, but who have not indicated a major field, are designated as *unclassified*. Unclassified students may take courses for graduate credit but may not apply more than 15 credits earned while in the unclassified status to any program leading to an advanced degree at this institution.

Provisional admission may be granted to applicants who lack undergraduate work considered essential for graduate study in the major field. Course work, without graduate credit, will be required to make up such deficiencies before admission to full graduate status can be granted.

Graduates from non-accredited institutions may be granted provisional admission when their academic records warrant. Additional course work may be required of such students when deficiencies in their previous training are apparent.

Graduates from accredited institutions whose scholastic records are below the standards for admission to full graduate standing may be admitted provisionally when unavoidable extenuating circumstances affected their undergraduate averages or when progressive improvement in their undergraduate programs warrant. All such students are required to take the Graduate Record Examinations and to submit scores to the Graduate Office in support of their application. The National Teacher's Examination may be substituted for the Graduate Record Examination if recommended by the department head. Information as to the dates on which the Graduate Record and the National Teacher's Examinations are given may be obtained at the Graduate Office.

Graduate students admitted on a provisional status may attain full graduate standing when the deficiencies responsible for their provisional status have been corrected. They also must have maintained a satisfactory academic record in all course work taken as a part of their graduate program.

Special Students. Holders of Bachelor's degrees from accredited institutions who desire special training in a given area for which they are otherwise qualified but do not desire credit towards an advanced degree may be admitted as special graduate students if facilities are available. Courses taken as a special student cannot be used for credit towards graduate degrees.

Applications for admission to the Graduate School should be on file in the Graduate Office at least thirty days in advance of the registration date for the term in which the student wishes to enroll in the Graduate School.

Students who apply for admission to the Graduate School without having allowed sufficient time for the study of completed transcripts, or prior to the receipt of their scores on the Graduate Record Examinations, may be admitted as special students. When evaluation of completed transcripts or satisfactory performance on the Graduate Record Examinations warrant, such students may be transferred during the term to full or provisional status. Unless transcripts or Graduate Record Examination scores are received within a reasonable time after admission or when evaluation of transcripts or scores on the Graduate Record Examinations indicate unsatisfactory qualifications for graduate study, no graduate credit may be received for course work.

The Office of Registration must have written authorization from the Associate Dean of the Graduate School before any graduate student will be given a permit to register. This permit will be sent by the Associate Dean at the time the student is notified of his acceptance.

A full-time graduate load is considered to be 15 credits per term. This course load restriction is made so that graduate students may have time for reading and contemplation well beyond the limits set for satisfactory undergraduate work. In exceptional cases one or two additional credit hours may be added to the roster if necessary in order to get pre-requisite work which is not taught in subsequent terms, provided the corresponding adjustment is made in the other terms. Rosters with additional credit hours beyond 15 should be accompanied by a special note indicating the reasons for the additional work.

Full-time employees (assistants and instructors) may carry not to exceed 6 credits during each term of the academic year.

Employees of professorial rank are not permitted to carry graduate work for credit.

Half-time employees, such as teaching and research fellows, are permitted a maximum course load of 9 credits per term unless corresponding adjustments are made in the service obligations of the employee during the same term. Half-time employees may not receive credit for more than 27 hours of work during the academic year of three terms.

A member of the senior class of State College may, upon approval of the Associate Dean of the Graduate School, register for courses in the 400 or 500 group for graduate credit to fill a roster of studies not to exceed 15 credits in any term. Not more than 10 hours of graduate credit may be acquired by an undergraduate student. Under no circumstances may an undergraduate receive credit for a course in the 600 group.

Members of the faculty of State College having a rank higher than that of instructor may not be considered as candidates for advanced degrees in the Consolidated University of North Carolina.

All regularly enrolled graduate students must take a physical examination. Preferably this should be given by the family physician on forms provided by the College. When this is not done the examination may be taken at the College during registration. A fee of \$5.00 will be charged for the examination when it is given by the College physician.

Admission to Candidacy for Graduate Degrees

Admission to the Graduate School does not constitute admission to candidacy for a graduate degree. Application for admission to candidacy for graduate degrees must be submitted to the Administrative Board of the Graduate School. Applications of students preparing for the Master's degree may not be filed before the satisfactory completion of one full term of graduate study and must be presented before the beginning of the last term in residence. Approval of the application will be determined by the quality of the scholastic record and on the certification by the major department that the student is qualified to continue advanced work. Admission to candidacy for the doctorate is granted upon satisfactory completion of the qualifying or preliminary examinations.

MASTER OF SCIENCE DEGREE

The Master of Science degree is awarded at State College after completion of a course of study in a specialized field in Agriculture, Education, Engineering, Forestry or Textiles; demonstration of ability to read a modern foreign language; completion of a satisfactory thesis and of comprehensive examinations in the chosen field of study.

In addition to complying with these requirements, the candidate for the Master of Science degree is expected to achieve high levels of scholarship. Graduate study is distinguished from undergraduate work by its emphasis upon independent research. The graduate student is as much interested in the significance of facts as in the accumulation of data. He is concerned with the materials of learning and the organization and interpretation of these materials.

A graduate student's program of study is planned so as to provide a comprehensive view of some major field of interest and to furnish the training essential for successful research in this field and related areas of knowledge. As great a latitude is permitted in the selection of courses as is compatible with a well-defined major interest. The program of course work is selected with the object of making possible a reasonable mastery of the subject matter in a specialized field. Training in research is provided to give the student familiarity with the methods, ideals, and goals of independent investigation. Since there are many possible combinations of courses, the administration of graduate programs calls for personal supervision of each student's plan of work by a special advisory committee of the graduate faculty. (See page 21.) The program of course work to be followed by the student as a part of the requirements for the Master's degree and the thesis problem selected must be approved by the student's advisory committee and the Associate Dean of the Graduate School.

Credits.—1. For the Master of Science degree a minimum of forty-five term credits is required.

2. Not more than ten of the academic credits required for a graduate degree will be accepted from other institutions.

3. No graduate credit will be awarded for excess undergraduate credit from any other institution.

4. All work credited toward a master's degree must be completed within six calendar years.

5. No graduate credit is allowed for courses taken by correspondence. A maximum of 10 credits may be obtained in extension study in the field of Education provided the extension courses are taught by a member of the Graduate Faculty and provided the courses are given graduate ranking by the Graduate School. Courses taken by extension are accepted for graduate credit only when the student has been admitted to the graduate school and when notice of registration is filed with the Graduate Office. Courses taken by extension do not reduce the residence requirement. Credit for extension courses reduces the amount of credit that may be transferred from other institutions by the amount of graduate credit granted.

Residence.—A candidate for a Master of Science degree is required to be in residence at the College, pursuing graduate work, one full academic year of three terms. The candidate is not permitted to take courses leading to forty-five credits in a shorter time.

Six summer schools of six weeks in residence at the College are sufficient to fulfill the residence requirement.

Graduate students carrying a course load of from six to nine hours are allowed two-thirds of full residence credit. Graduate students registered for less than six hours receive one-third of full residence credit.

Graduate students registered for a full load (6-9 hours) in the six weeks summer term receive residence credit for one-half of a regular academic term. A half-time course load in the summer session is equivalent to one-quarter residence credit.

The forty-five credit hour requirement for the Master's degree represents the minimum quantity of work acceptable. The credit hours required of graduate students usually exceed the minimum requirements. Inadequate preparation and thesis research frequently make additional work necessary.

Courses of Study.—The program of the student shall contain at least twelve credits in courses of the 600 group, no more than nine of which may be allowed for research study. Graduate students may use not more than three courses of the 400 level for credit on programs leading to the Master's degree. To be acceptable for graduate credit, courses bearing a 400 number must fall in other than the student's major field of interest.

During the first term in residence an advisory committee of at least three faculty members, one representing the field of the minor, will be appointed by the Associate Dean, after consultation with the head of the major department, for each student engaged in a program of work leading to the Master's degree. Advisory committees for doctoral students must have at least five members, at least one of whom shall represent the minor field. The advisory committee will meet with the student and prepare a program of course work to meet the requirements of the student's graduate objectives. Four copies of the program, prepared on forms provided for this purpose, must be approved by each member of the committee, by the head of the major department and the Associate Dean of the Graduate School. After approval in the Graduate Office, three copies

will be returned to the department head, one for his files, one for the chairman of the advisory committee and one for the student.

The courses taken by a graduate student shall constitute a well-rounded but unified plan of study. This is interpreted to mean that the program of research and course work shall be divided between a major and a minor field. While there are no inflexible rules which govern the number of credit hours that must constitute the major and minor, in general, it is expected that approximately two-thirds of the course work will fall in the major and one-third in the minor. The detailed course requirements for each graduate student program are left to the judgment of the advisory committee.

Class Work.—A graduate student is expected to show greater initiative in exploring the possibilities of the subject matter presented in the courses he takes than is the undergraduate. He is also expected to recognize the significance of facts and to assume a responsibility for relating data to theoretical concepts. In preparation, attendance, and in all the routine of class work the graduate student is subject to the regulations observed in other divisions of the college.

Grades.—A minimum grade of B must be made on all formal course work to obtain graduate credit. An average of B must be obtained on all course work taken as a part of the student's graduate program. Failure to maintain a B average in any term will place the student upon probation. Any student whose academic record fails to meet the B average requirement for two consecutive terms will not be permitted to continue a graduate program without the written approval of the Associate Dean.

Grades in research and seminar courses are given in terms of S (satisfactory) or U (unsatisfactory) in place of the symbols used for formal course work.

The grade *Incomplete* (Inc.) may be used in research or laboratory courses when circumstances beyond the control of the student have prevented completion of the work by the end of the academic term. An incomplete grade may be given only after approval by the Associate Dean and must be converted to one of the usual symbols before the end of the next academic term.

Language Requirements.—A reading knowledge of at least one modern foreign language is required of candidates for the Master of Science degree. Ordinarily this language will be German, though French may be used where this language is important in the field of the student's major interest. Substitution of some other modern foreign language for the German or French requires written approval of the Department Head and the Associate Dean of the Graduate School. The language requirement must be satisfied at least one term before the degree is awarded.

Proficiency in languages is determined by the Department of Modern Languages on the basis of a traditional reading knowledge examination. Students whose language preparation is adequate may take their language examination by appointment at any time during the academic year. The Department of Modern Languages offers course work to assist graduate students who desire to improve their comprehension of foreign languages but no course work in language is required of graduate students. Graduate students who expect to complete the requirements for the M.Sc. degree

should confer with the Head of the Department of Modern Languages soon after registration to formulate plans for meeting the language requirements of this degree.

Students whose native language is other than English may meet the foreign language requirements for the Master of Science degree by demonstrating a satisfactory mastery of English. Examinations in English are conducted by the English Department.

Thesis.—A candidate for the Master of Science degree must prepare a thesis representing an original investigation. The subject of the thesis must be approved by the Head of the Department in which the major work is done and by the student's advisory committee. Three copies of the thesis in final form must be filed in the graduate office at least one month before the degree is awarded. Detailed instructions as to form and organization of the thesis may be obtained at the Graduate Office.

Examinations.—All candidates for the Master of Science degree must pass, with a grade of A or B, all formal course work specified as a part of the requirements for the degree. Graduate credit for research and seminar courses is granted when a grade of S is recorded in the Registration Office. In addition, the candidate must pass a comprehensive oral examination that is held to satisfy the examining committee that the candidate possesses a reasonable mastery of knowledge in the major and minor fields and that this knowledge can be used with promptness and accuracy. This examination may not be held until all other requirements except completing the course work of the last term, are satisfied but must be taken not later than two weeks before the end of the term in which the degree is to be awarded. Application for the comprehensive oral examination must be filed with the Associate Dean by the chairman of the advisory committee at least one week prior to the date on which the examination is to be held.

The oral examination will be conducted by an examining committee appointed by the Associate Dean. The chairman of the examining committee will be the chairman of the student's advisory committee. At least two additional members will be appointed to represent the major and minor fields. The comprehensive oral examination is open to all faculty members who care to attend but the decision as to the candidate's fitness rests solely with the examining committee.

At the discretion of the examining committee, written examinations covering the subject matter in the major and minor fields also may be required of the candidate. Written examinations, when required, may not be held earlier than the end of the first month of the last quarter in residence, and not later than one week before the comprehensive oral examination.

The final examinations for candidates for the Master's degree may not be held until the thesis, in complete and final form, bearing the signature of the chairman of the student's advisory committee, has been submitted to the Graduate Office.

MASTER'S DEGREE IN A PROFESSIONAL FIELD

This degree is offered for students who are interested in the more advanced applications of fundamental principles to specialized fields rather than in the acquisition of the broader background in the advanced scientific

studies which would fit them for careers in research. Students working for this degree ordinarily will terminate their graduate work at this point.

Examples of the types of degrees that may be awarded upon the completion of the course of study in a professional field are:

Master of Agricultural Education

Master of Forestry

Master of Agronomy

The degree is not offered in the Schools of Engineering and Textiles.

The chief characteristics of these degrees is that the changes made in requirements permit, in greater measure, the satisfaction of what are represented as professional needs than do the requirements for the conventional Master of Science degree. The most important modification in the requirements and principles is the granting of relatively greater dispersion in programs of study than is permissible under a strict application of the principle of interrelation of subjects in a specialized field.

Language Requirements.—The candidate for a Master's degree in a professional field is exempt from the requirements of a reading knowledge of a modern foreign language.

Thesis Requirements.—In the School of Education the thesis requirement for the Master's degree in each of the specialized fields may be waived by the department in which the degree is sought. When the thesis requirement is waived the student must complete the course introduction to Educational Research, or departmental course in research and a problem report. A thesis is required for the professional degree in Agriculture and Forestry.

Other Requirements.—The other requirements for the Master's degree in a professional field are the same as for the Master of Science degree.

SUMMARY OF PROCEDURES FOR THE MASTER'S DEGREE

1. Letter of inquiry from prospective student to Graduate Office or Department Head.
2. Mailing of proper forms to student by Graduate Office or Department Head.
3. Receipt of application form by Graduate Office.
4. Application with transcript sent to Department Head for study.
5. Department Head recommends acceptance of prospective student stating curriculum in which he will work and the degree sought.
6. Assuming the prospective student meets the minimum scholastic standards, notice of acceptance is mailed to him by the Graduate Office. When the student's academic record fails to meet the minimum scholastic standards of the Graduate School, provisional admission may be granted upon submission by the student of evidence of a satisfactory performance on the Graduate Record or National Teacher's Examinations. The National Teacher's Examination is accepted only when approved by the Department Head and the Graduate Dean.
7. Permit to register is sent by Graduate Office to the Registrar.
8. Student arrives, reports to the Department Head, is assigned an adviser, and makes out a roster of courses in consultation with departmental adviser.
9. Advisory committee of 3 faculty members, one of whom represents the minor field, appointed in the first term of graduate study by the Graduate Office after consultation with the Department Head.

10. Plan of work prepared by the advisory committee in consultation with the student and submitted in quadruplicate to the Graduate Office by the end of the first term in residence.
11. Plan of work approved by the Graduate Dean and three copies returned to the Department Head. One copy is kept in department files, one goes to the adviser, and one is given to the student.
12. A thesis subject is selected and an outline of the proposed research submitted to the Department Head and the chairman of the student's advisory committee. Students preparing themselves for the professional degree in specialized fields of Education should consult the chairman of their committees with reference to their problem report.
13. Student passes language examination. This must be done at least one term before the degree is to be awarded. Students preparing themselves for the master degree in a professional field are not required to pass a language examination.
14. Student applies for admission to candidacy for the Master's degree. Application must be filed before the beginning of the last term in residence.
15. Application is reviewed by the head of the major department and by the Administrative Board and if approved the student becomes a candidate for the degree.
16. A copy of a preliminary draft of the thesis is submitted to the chairman of the student's committee for criticism. No thesis is required of candidate for the master degree in specialized fields of Education.
17. Corrected draft of the thesis submitted to members of the student's advisory committee for additional suggestions and criticisms.
18. Four copies of the thesis in final form approved by each member of the students advisory committee and signed by the adviser are submitted to the Graduate Office *at least one month prior to awarding of the degree.*
19. Permission for student to take final examination requested of Graduate Office by chairman of student's advisory committee at least one week before the examination is to be held. Permission will not be granted until thesis in final and complete form has been received in the graduate office.
20. Permission granted by Graduate Dean—date is set and examining committee appointed.
21. Report of the examination sent to the Graduate Office at least two weeks prior to the date the degree is to be awarded.
22. Graduate Office certifies to the Registration Office and to the General Faculty that all requirements for the degrees have been met and recommends the awarding of the degree.

THE DEGREE OF DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered in the following departments:

Agricultural Economics
Agronomy
Animal Industry
Botany (in the fields of physiology and ecology)

Ceramic Engineering
Chemical Engineering
Electrical Engineering
Engineering Physics
Entomology
Experimental Statistics
Genetics
Nuclear Engineering
Plant Pathology
Rural Sociology
Zoology (in the fields of ecology and wildlife conservation.)

REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The Doctor's degree symbolizes the fact that the recipient is capable of undertaking original research and scholarly work at the highest levels without supervision. Therefore, the degree of Doctor of Philosophy is not granted on a basis of the successful completion of a given amount of course work, but rather upon the demonstration by the candidate of a comprehensive knowledge and high attainments in scholarship and research in a specialized field of study. These attainments are determined by the quality of the thesis which the candidate prepares to report the results of original investigations and by passing successfully a series of rigorous and comprehensive examinations on the special and related fields of study.

Residence.—A minimum of nine full terms of work beyond the Bachelor's degree is required for the Doctor of Philosophy Degree. At least three consecutive terms must be spent in residence at N. C. State College. Ordinarily, students who have the Master's degree will require two additional years of full time study to meet the requirements of the Doctor of Philosophy degree. At least one of these years must be spent in continuous residence at the Consolidated University of North Carolina.

The amount of credit granted for work accomplished at other institutions will be determined by the Associate Dean after consultation with the student's advisory committee at the time the plan of graduate work is filed.

Course of Study.—At the time of admission the student should, with the advice of the chairman of the department, elect a major field. During the first term in residence an advisory committee will be appointed by the Associate Dean after consultation with the Department Head to prepare with the student a plan of graduate work. Four copies of the program thus outlined, signed by all members of the advisory committee are referred to the Associate Dean for approval. When approved three copies are returned to the Department Head, one being retained in the department files, a second copy is given to the chairman of the advisory committee, and the third copy is given to the student. The subject of the thesis must appear on the plan of work and any subsequent changes in the subject of the thesis or in the plan of graduate work must be reported to the Graduate Office for approval.

There are no definite requirements in credit hours for the Doctor's degree. Emphasis is placed upon a comprehensive knowledge of a well defined and recognized field and related subjects. There shall be a major and one or two minor areas of specialization. The minor field ordinarily

will consist of at least thirty credit hours. These may fall in an allied department or in the major department. A minor in the department of the major is permitted only when the department offers recognized divisions of study other than that designated as the major field.

Languages.—A reading knowledge of scientific literature in two modern foreign languages is required for the Doctor of Philosophy degree. German and French usually meet the language requirements. Substitution of another modern language for German or French will be permitted only when the language substituted is of greater importance in the prosecution of the research study. Substitution of another modern language for German or French requires the written approval of the Department Head and the Associate Dean. The language requirements must be satisfied before the qualifying examinations can be taken.

Proficiency in languages is determined by the Department of Modern Languages on the basis of a traditional reading knowledge examination. Students whose language preparation is adequate may take their language examination by appointment at any time during the academic year. The Department of Modern Languages offers course work to assist graduate students who desire to improve their comprehension of foreign languages but no course work in language is required of graduate students. Graduate students who expect to complete the requirements for the Ph.D. degree should confer with the Head of the Department of Modern Languages soon after registration to formulate plans for meeting the language requirement of this degree.

Students whose native tongue is some language other than English may use English as one of the languages required for the Doctor of Philosophy degree. When English is submitted in partial fulfillment of the language requirements, the native language may not be used to satisfy the language requirements. Examinations in English will be given by the English Department, and a statement certifying the candidate's proficiency in English must be filed in the Graduate Office before the qualifying examination may be taken.

The Dissertation.—The doctoral dissertation presents the results of the candidate's original investigations in the field of his major interests. It must represent a contribution to knowledge adequately supported by data and written in a manner consistent with high standards of excellence in scholarship. Detailed instructions relating to the thesis may be obtained in the Graduate Office.

Publication of the results obtained in the thesis investigation is expected. Each copy of the thesis must be accompanied by an abstract of approximately 500 words. The abstract will be published by the College if the thesis material itself is not published.

The dissertation will be examined by all members of the examining committee and must receive their approval to be acceptable to the Graduate Office. Approval of the committee is indicated by the signature of the chairman of the examining committee upon the title page of the thesis.

Three copies of the thesis in final form and bearing the signature of the chairman of the student's advisory committee must be presented to the Graduate Office not later than one month before the date on which the degree is to be awarded.

Examinations.—Not earlier than the end of the second year of graduate study and at least before the end of the third week of the academic year in which the degree is expected, a qualifying or preliminary examination (these are synonymous terms) shall be given by a special committee appointed by the Associate Dean. The examining committee usually consists of the student's advisory committee but may include any other members of the Graduate Faculty. The examinations are open to all members of the Graduate Faculty who may care to attend. Authorization to the student and to the department for holding the preliminary oral examination must be secured from the Graduate Office. Official printed forms are supplied for this authorization and for a report of the results of the examination.

The examination consists of two parts: (1) written examinations prepared separately by each member of the examining committee and (2) an oral examination held before the entire examining committee. The purposes of the examinations are to determine the student's mastery of the subject matter in the major and minor fields and to determine the student's readiness and capacity for original research study. The preliminary examinations shall cover all of the course work taken by the student and may include any subject logically related and basic to an adequate understanding of his major or minor areas of study. The preliminary examinations do not cover the thesis.

A final oral examination is also required. This examination is held after the thesis work has been completed and consists in a defense by the candidate of the methods used and the conclusions reached in his research study. The examination is conducted by an examining committee. The examining committee usually consists of the student's advisory committee, plus a representative of the Graduate School, although this procedure is not always adopted. The examining committee is appointed by the Associate Dean after consultation with the head of the student's major department.

The final oral examination may not be held until the thesis in complete and final form, bearing the signature of the chairman of the student's advisory committee as evidence of committee approval has been submitted to the Graduate Office.

Failure of a student to pass either the preliminary or the final examination terminates his graduate work at this institution unless otherwise recommended by the examining committees. No re-examination may be given until at least one full term has elapsed since the first examination. Only one re-examination is permitted.

Admission to Candidacy.—A student is admitted to candidacy upon successfully passing the preliminary examinations. The language requirements must be fulfilled before permission to take the preliminary examination will be granted. Admission to candidacy must be obtained before the end of the third week in the academic year in which the degree is expected; i.e., nearly three full terms before the degree is awarded.

Thesis Regulations.—A booklet containing detailed instructions about the form of dissertation may be obtained at the Graduate Office.

Further information about graduate work at State College may be secured from D. B. Anderson, Associate Dean of the Graduate School, N. C. State College, Raleigh, N. C.

SUMMARY OF PROCEDURES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

1. Letter of inquiry from prospective student to Graduate Office or Departmental Head.
2. Mailing of proper forms to student by Graduate Office or Department Head.
3. Receipt of application forms by Graduate Office.
4. Application with transcript sent to Department Head for study.
5. Department Head recommends acceptance of prospective student stating curriculum in which he will work.
6. Assuming the prospective student meets the minimum scholastic standards, notice of acceptance is mailed to him by the Graduate Office.
7. Permit to register is sent by Graduate Office to the Registrar.
8. Student arrives, reports to the Department Head, is assigned an adviser, and makes out a roster of courses in consultation with departmental adviser.
9. Advisory committee appointed in the first term of graduate study by the Graduate Dean after consultation with the Department Head.
10. Plan of work prepared by the advisory committee in consultation with the student and submitted in quadruplicate to the Graduate Office by the end of the first term in residence.
11. Plan of work approved by the Graduate Dean and three copies returned to the Department Head. One copy is kept in department files, one goes to the adviser, and one is given to the student.
12. A thesis subject is selected and an outline of the proposed research submitted to the Department Head and the chairman of the student's graduate committee.
13. Student passes language examinations. These are usually in German and French, though other languages may be accepted with the written approval of the Department Head and the Associate Dean of the Graduate School. Foreign students may submit a reading knowledge of English in partial fulfillment of the language requirement.
14. The chairman of the student's advisory committee requests permission to hold the qualifying examination. This must be done not earlier than the end of the second year, and at least before the end of the third week of the academic year in which the degree is to be awarded.
15. Permission to take qualifying examination granted by Graduate Dean if the student's record is in order. A date is set and examining committee appointed. The examination consists of two parts—a written and an oral.
16. A report of the examination is sent to the Graduate Office. If favorable, the student is admitted to candidacy.
17. A copy of a preliminary draft of the thesis is submitted to the chairman of the student's committee for criticism.
18. Corrected draft of the thesis submitted to members of the student's advisory committee for additional suggestions and criticisms.
19. Four copies of the thesis in final form approved by each member of the Students Advisory Committee and signed by the adviser are submitted to the Graduate Office *at least one month prior to awarding of the degree.*

20. Permission for student to take final examination requested of Graduate Office by chairman of the student's graduate committee at least one week before the examination is held.
21. Permission granted by Graduate Dean if the student's record is in order, a date is set and examining committee appointed.
22. Report of the examination sent to the Graduate Office at least one week prior to the date at which the degree is to be awarded.
23. Graduate Office certifies to the Registration Office and to the General Faculty that all requirements for the degree have been met and recommends the awarding of the degree.

FEES FOR GRADUATE STUDENTS

Subject to the approval of the Board of Trustees, the charges for graduate students at N. C. State College will be as follows:

FALL TERM

Course Load	In-State Students			Out-of-State Students		
	Fees	Tuition	Total	Fees	Tuition	Total
10-15 cr. hrs.	\$49.00*	\$50.00	\$99.00	\$49.00	\$120.00	\$169.00
9 cr. hrs.	38.00*	30.00	68.00	38.00	72.00	110.00
Less than 9 cr. hrs.	38.00*	25.00	63.00	38.00	60.00	98.00

*Students in Agriculture and Agricultural Education will pay \$1.00 additional fee in the fall term.

WINTER TERM

Course Load	In-State Students			Out-of-State Students		
	Fees	Tuition	Total	Fees	Tuition	Total
10-15 cr. hrs.	\$44.00	\$50.00	\$94.00	\$44.00	\$120.00	\$162.00
9 cr. hrs.	33.00	30.00	63.00	33.00	72.00	105.00
Less than 9 cr. hrs.	33.00	25.00	58.00	33.00	60.00	93.00

SPRING TERM

Course Load	In-State Students			Out-of-State Students		
	Fees	Tuition	Total	Fees	Tuition	Total
10-15 cr. hrs.	\$37.00	\$50.00	\$87.00	\$37.00	\$120.00	\$157.00
9 cr. hrs.	26.00	30.00	56.00	26.00	72.00	98.00
Less than 9 cr. hrs.	26.00	25.00	51.00	26.00	60.00	86.00

SPECIAL ARRANGEMENTS

Qualified graduate students who by reason of full-time professional employment are not resident students may register for one course during each academic term at rates prevailing in the Extension Division.

SUMMER SCHOOL

Registration Fee	\$4.00
Tuition (In-State Students per credit hour)	5.00
Tuitions. Out-of-State Students per credit hour	7.00

All graduate students holding college appointments (i.e., receiving a regular monthly salary check) will be charged the in-state rate of tuition.

Incidental fees cover all laboratory fees—no additional charges are made for any laboratory courses.

Faculty members desiring to take one course per term will be charged one-half of the in-state tuition rate but will not be required to pay incidental fees. They will not be entitled to any of the privileges provided by the fees.

A graduate student registered for course work is entitled to one audit free of charge and will be charged \$5.00 for each additional audit per term.

A diploma fee of \$10.00 is charged all students receiving a graduate degree.

A fee of \$5.00 will be charged for a physical examination when given by the college physician.

All graduate student fees are subject to change without notice when the changes are authorized by the Board of Trustees.

In order to draw a clear line between in-state and out-of-state students, the Administration has ruled that all students whose parents have not been domiciled in North Carolina for more than six months immediately preceding the day of their first enrollment in the institution shall be termed out-of-state students, with the following exceptions:

- (1) Students twenty-one years of age at the time of their first matriculation who have resided in North Carolina for more than one year preceding the day of their first enrollment;
- (2) Children of regular employees of the Federal Government stationed in the State of North Carolina; and
- (3) Children of regular employees of the Federal Government who are employed outside of the State, but who through law are permitted to retain their North Carolina citizenship.

Students cannot claim a change in their resident status after matriculating. Students furnishing incomplete or incorrect information in order to obtain the special State-resident status shall be liable for dishonorable dismissal.

Graduate students employed by the College or the Experiment Station on a part-time basis are not permitted to register for a full-time load of course work. The Veterans Administration will classify such students as full-time students when it is officially certified by the Associate Dean of the Graduate School that the student is engaged in a full-time program of professional work.

Fellowships and Graduate Assistantships

Graduate Fellowships are funds offered to graduate students to assist in the support of programs of advanced study. Holders of Fellowships have no service obligations to the College and may devote full time to the prosecution of their graduate programs.

The E. G. Moss Fellowship in tobacco research sponsored by the N. C. State Grange carries a stipend of \$2,700 a year for predoctoral appointments and a stipend of \$3,300 a year for post doctoral appointments. The award is made annually to an outstanding student under 35 years of age who holds a Master of Science degree or its equivalent. The holder of this fellowship must undertake a research project on tobacco in any one of the

following fields: Agricultural Economics, Agronomy, Botany, Chemistry, Entomology, Genetics, Plant Pathology, Plant Physiology, or Soils.

The Celanese Corporation sponsors a fellowship with a stipend of \$1,800 annually, plus tuition and fees, for graduate students with a major in Textile Chemistry or Textile Physics.

The Monsanto Chemical Company sponsors a fellowship amounting to \$1,200 annually for graduate students with a major in Textile Chemistry or Textile Physics. The Celanese and Monsanto fellowships are open to students having a Bachelor's degree in Physics, Chemistry, Chemical Engineering, or Textiles.

The Honor Society of Phi Kappa Phi Fellowship, State College Chapter, offers \$50 annually, preferably to a member of the Society, to assist in promoting research, and advanced training of worthy students.

Fellowships are also sponsored by the following agencies: the Edward Orton, Jr. Ceramic Foundation, the Norfolk and Southern Railroad Company, the Sperry Gyroscope Company, and the Western North Carolina Ceramic Mineral Producers.

Information relative to stipends, areas of research study supported by specific fellowships and application forms may be obtained from the Graduate School or from the heads of the appropriate departments.

Graduate Assistantships are granted to selected students who devote some part of their time to service duties for the College. Teaching assistantships carry a stipend of \$1,200 for the academic year and permit the holder to enroll for sixty per cent of a full course load. The stipends for research assistantships range from \$1,500 to \$1,800 for a 12 months' appointment. The College offers 33 teaching assistantships and 24 research assistantships each year. Some of these are supported by funds granted by the following agencies: the American Potash Institute, the Atomic Energy Commission, the Chilean Nitrate Education Bureau, Inc., the Lilliston Implement Company, the Lilly Company, the McLean Trucking Company, the North Carolina Department of Motor Vehicles, the North Carolina State Optometric Society, the Office of Naval Research, the Pacific Coast Borax Company, the Ralston-Purina Company, the Tennessee Corporation, and the Solvay Process Division of the Allied Chemical Company.

Residence Facilities

Dormitory facilities are provided on the campus for graduate students. Single or double rooms are available. The rental charge for single rooms is \$52.50 per term and for double rooms is \$35.00 per term.

DESCRIPTION OF COURSES

The courses described on the following pages are planned for the academic year 1953-54 unless otherwise indicated. Specific courses may not be offered, however, if registration for the course is too low or if faculty or facilities become unavailable.

Courses for which graduate credit may be received are numbered in three categories. Courses with a number in the 400 series carry no graduate credit when they fall in the student's major field of interest. Graduate credit will be allowed for no more than 3 courses at the 400 level in the student's minor area of study.

Courses bearing a number in the 500 series are open to both seniors and graduate students. All courses in this series carry full graduate credit.

Courses given a 600 series number are open only to graduate students.

AGRICULTURE

Agr. 401. Principles and Techniques of Extension Education

0-0-3

A study of the background, development, and operation of the Agricultural Extension Service. Consideration is given to major events leading to the establishment of Agricultural Extension, its objectives, organization, and philosophy. Major emphasis is placed on principles underlying Extension education together with techniques of program building and teaching.
Mr. Sloan.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Graduate Faculty

Professors: HERMAN BROOKS JAMES, Head, GARNET WOLSEY FORSTER, WOODROW WILSON MCPHERSON.

Associate Professors: CHARLES EDWIN BISHOP, RUDOLPH E. FREUND, RICHARD ADAMS KING, LEE ROY MARTIN.

The Department of Agricultural Economics offers a program of study leading to the Master of Science and Doctor of Philosophy degrees. Special emphasis is placed upon the economics of agricultural production and marketing, analysis of programs and policies affecting agriculture, and statistical techniques which aid in solving agricultural problems. The program of study includes courses in advanced economic theory with special adaptation and application to agriculture. Requirements for advanced degrees include the preparation of a thesis dealing with a recognized problem in agriculture which provide students with additional training in the use of the analytical tools acquired through their program of study.

The rapid growth and development of industry and agriculture in North Carolina and throughout the South has resulted in an increased demand for specially trained workers throughout the region. This demand far exceeds the number who have the necessary training to perform the many duties associated with the complex and technical details of a developing economy. Many graduates of the Department of Agricultural Economics are employed in various agencies of the Federal and State governments engaged in research and educational work. Others are engaged in professional work with commercial organizations dealing in agricultural credit and the production and marketing of agricultural products.

The Department is located on the second floor of Patterson Hall and is well supplied with all the modern equipment essential to its extensive

research and teaching program including the latest models of calculating and adding machines, dictation and transcribing equipment. In addition, it has a modern and well equipped departmental library, including an excellent set of references to all the major professional journals in the field of Agricultural Economics and Experiment Station publications from other institutions throughout the United States.

The program of teaching and research has been advanced through a special grant of funds which makes it possible to bring visiting professors to the State College campus for periods up to a full quarter. These visitors, including such outstanding economists as J. D. Black, T. W. Schultz, W. W. Leontief, W. H. Nicholls, H. R. Tolley, D. G. Johnson, E. O. Heady and others who are available for consultation on research problems and the more formal seminar discussions.

Courses for Advanced Undergraduates

- Agr. Econ. 413. Farm Appraisal.** 0-0-3
Prerequisite: Agr. Econ. 303.
The fundamentals of farm appraisal and practical methods of evaluating farms of various types and sizes. Mr. James.
- Agr. Econ. 422. Agricultural Cooperation.** 0-3-0
Prerequisite: Agr. Econ. 311.
Cooperative principles and practices, organization problems, and operating practices, as applied to farmers' buying, selling, and service cooperatives. Staff.
- Agr. Econ. 431. Agricultural Prices.** 3-0-0
Prerequisite: Agr. Econ. 311.
Behavior of agricultural prices: their relation to consumption, production of farm products, and marketing practices; methods of price analysis applied to agricultural products. Mr. Pierce.
- Agr. Econ. 432. Agricultural Finance.** 0-3-0
Prerequisite: Agr. Econ. 303.
Types and sources of agricultural credit used in financing the production and marketing of agricultural products; analysis of the credit structure in agriculture and the need for credit in agricultural development. Mr. Pierce.
- Agr. Econ. 442. Marketing Field Crops.** 0-4-0
Prerequisite: Agr. Econ. 303.
A study of buying and selling decisions faced by the farmer growing field crops; price making forces in agricultural markets; products and problems in connection with the making of cotton, tobacco, grain and oil seeds. Staff.
- Agr. Econ. 462. Marketing Dairy Products.** 0-3-0
Channels of distribution and consumption, price plans and bases of price quotations, factors affecting efficiency of plant operation and distribution, Federal regulations of milk marketing, and a review of dairy marketing research. Staff.
- Agr. Econ. 464. Marketing Fruits and Vegetables.** 0-4-0
Prerequisite: Agr. Econ. 303.
Trends in consumption and production, channels of distribution, sales methods, marketing agencies and facilities, economic implications of pre-packaging, and the role of State and Federal agencies. Staff.
- Agr. Econ. 472. Marketing Livestock and Meats.** 0-4-0
Prerequisite: Agr. Econ. 311, 303.
This course is designed to give an understanding of the type and nature of livestock markets and marketing agencies; the influence of grade, quality, seasonality of sale, and market outlet on price and price differentials; principal practices followed in selling livestock in the Southern States; and extent of governmental regulation and supervision of livestock marketing. Emphasis will be placed on livestock marketing problems in the South as they affect farm income and marketing costs. Staff.

Courses for Graduates and Advanced Undergraduates

Agr. Econ. 502. Monetary and Fiscal Policies in Relation to Agriculture

0-3-0

Prerequisite: Consent of Instructor,

Economic theory underlying monetary and fiscal policies; the interrelationships between monetary and fiscal policy and agricultural production, prices and incomes; introduction to the analysis of the relationships among the economic aggregates—the national income, employment, production, consumption, interest, wage levels, prices, etc., and the analysis of their fluctuations.

Mr. Martin.

Agr. Econ. 512. Land Economics

3-0-0

Prerequisite: Agr. Econ. 303.

Theoretical aspects of the supply and utilization of land; analysis of the economic problems connected with farm tenancy, soil conservation, and the transfer of property.

Mr. Freund.

Agr. Econ. 521. Farm Marketing II

0-3-0

Prerequisite: Agr. Econ. 311.

Examination of farm marketing problems and critical evaluation of marketing methods and practices.

Mr. King.

Agr. Econ. 523. Farm Management II

0-0-3

Prerequisite: Agr. Econ. 303.

The application of fundamental principles involved in the theory of the firm to the problems of farm organization and operation; use of production functions in economic analysis as a basis for managerial decisions; the development of county agricultural programs.

Mr. James.

Agr. Econ. 533. Agricultural Policy

0-0-3

Prerequisite: Agr. Econ. 311.

The historical development of agricultural policies and action programs of the Federal Government from 1929 to date; the economic significance of the basic policy concepts involved, such as parity, market supports, acreage control, and soil conservation; the functions and effects of the programs under changing economic conditions and from the viewpoints of special farm groups, regions, and the economy as a whole.

Mr. Freund.

Agr. Econ. 551, 552, 553. Agricultural Economics

3-3-3

Prerequisites: Econ. 301, 302 and Agr. Econ. 303, or equivalent.

An intermediate course in economic principles and their application to agriculture. Emphasis will be placed on the development of the tools and concepts necessary for economic analysis, and an attainment of facility in their use in analyzing economic problems in agriculture.

Messrs. King, Bishop and Martin.

Courses for Graduates Only

Agr. Econ. 602. International Trade in Relation to Agriculture.

0-0-3

Prerequisite: Agr. Econ. 502.

A thorough discussion of the principles of international trade, and inter-regional differentiation in the use of productive resources, will be followed

by the analysis of contemporary problems of trade relationships between countries heavily engaged in the import or export of agricultural products. Attention will be given to the United States and her position in the world economy today, and to recent attempts at regularizing the trade in staple products among the free nations.

Mr. Freund.

Agr. Econ. 621. Research in Agricultural Economics.

Credits by arrangement

Prerequisites: Fifteen hours in Economics and Agricultural Economics.

A consideration of the research method and procedure now being employed by research workers in the field of Agricultural Economics, including qualitative and quantitative, inductive and deductive methods of research procedure; choice of projects, planning, and execution of the research project.

A maximum of nine credits is allowed toward the Master's degree no limitation on credits in Doctorate programs.

Staff.

Agr. Econ. 631. Economic and Social Foundations of Agricultural Policy.

3-0-0

Prerequisites: Agr. Econ. 551, 552, and 553, or consent of Instructor.

A review of fundamental issues of policies of Western Economies, analysis of policy making processes, interdependency among economic, social, and political behavior in agriculture, and an introduction to the economic consequences of particular programs.

Mr. McPherson.

Agr. Econ. 632. Wage, Price, and Production Policies in Industry and Their Effects on Agriculture.

0-3-0

Prerequisites: Agr. Econ. 502, 631.

Theories of wages and employment, collective bargaining, and wage differentials. Industrial organization in the economy, price and production policies, integration, costs and prices in the cycle, and government policy and workable competition. Direct and indirect effects of labor and monopoly policies upon the employment of resources, national income and its distribution, and price levels, wages, and interest rates and upon economic magnitudes in agriculture.

Mr. Martin.

Agr. Econ. 633. Welfare Effects of Agricultural Policies and Programs.

0-0-3

Prerequisites: Agr. Econ. 502, 642, or equivalent and consent of instructor.

Description of the conditions defining optimal resource allocation. Application of the condition for maximum welfare in appraisal of economic policies and programs affecting resource allocation, income distribution and economic development.

Mr. Bishop.

Agr. Econ. 641. Economics of Consumption and Demand.

0-3-0

Prerequisites: Agr. Econ. 551 or permission of the Head of the Department of Agricultural Economics.

Issues in scope and methods in economic analysis; analysis of consumer behavior with regard to preference patterns and income expenditure, and aggregate demand; demand analysis with special consideration to agricultural commodities.

Mr. King.

Agr. Econ. 642. Economics of Production

0-0-3

Prerequisites: Agr. Econ. 641, or consent of Instructor.

Producer behavior with regard to factor combination, quantity and kind of output, and aggregate supply; supply analysis with particular reference to agriculture. Mr. McPherson.

Agr. Econ. 643. Economics of Markets and General Economic Interdependency.

3-0-0

Prerequisites: Agr. Econ. 641 and Agr. Econ. 642.

Economic analysis of product and factor markets, price formation, income distribution and their general interdependencies. Mr. James.

Agr. Econ. 651, 652. Analysis of Economic Development in Agriculture.

651 Summer Session only.

652

3-0-0

Prerequisites: Agr. Econ. 641, 642, 643, or equivalent.

A study of the conditions necessary for, and the processes of, economic progress of the individual farm and family and the economy; an analysis of the causes and consequences of continuous economic change—changes in technology, in factor supply, institutions, and in the structure of consumption; effects of rates of economic change on the level and pattern of employment, production, income and consumption, particularly in agriculture. Messrs. McPherson, Bishop.

Agr. Econ. 661, 662, 663. Seminar in Contemporary Economic Problems in Agriculture.

3-3-3

Prerequisite: Permission of Head of the Department of Agricultural Economics.

A critical review of the character and the causes of contemporary economic problems in agriculture with an appraisal of current and alternative means of handling these problems. Messrs. Forster, Freund, and James.

DEPARTMENT OF AGRICULTURAL EDUCATION

See Education.

DEPARTMENT OF AGRICULTURAL ENGINEERING

Graduate Faculty

Professor: GEORGE WALLACE GILES, Head.

Associate Professor: FRANCIS JEFFERSON HASSLER.

The Department of Agricultural Engineering offers advanced study in any one of four fields of specialization: Power and Machinery, Rural Structures, Land Improvement, or Rural Electrification. The course of study provides a broad background of basic science and engineering fundamentals as applied to agriculture.

Graduate programs for the Master of Agricultural Engineering are designed to prepare students in extension and professional work, while the Master of Science program is planned to furnish the training essential for teaching and research positions with state and federal institutions and industry. The dependence of modern agriculture on scientific methods and mechanical equipment has emphasized the need for men trained to

meet these problems. The demand for well trained agricultural engineers has not been satisfied and there seems little probability of its being met in the near future.

Graduate students in Agricultural Engineering have available the libraries of the Consolidated University of North Carolina and the research tools and equipment of all kinds in the Agricultural Experiment Station. The Department of Agricultural Engineering maintains a complete research shop manned by competent mechanics for the use of graduate students.

Extensive research programs in cotton mechanization, crop drying, curing of peanuts, hay, corn, and tobacco, irrigation, land drainage and other subjects underway in the Department offer unusual opportunities for graduate student research. Cooperative arrangements with the U.S.D.A. make it possible for graduate students to utilize the exceptional laboratory and field facilities at the Oxford Experiment Station.

Courses for Advanced Undergraduates

Agr. Engr. 401. Senior Seminar. One credit per term

Prerequisite: Senior standing in Agr. Eng.

Students will be assigned special problems, the results of which are to be presented in the class. Maximum of three credits allowed. Staff.

Agr. Engr. 413. Teaching Farm Shop Work. 0-0-3

Prerequisites: Agr. Engr. 311 and 312.

The use and care of power tools; shop management and methods of presenting the subject matter. Messrs. Howell, Coggin.

Agr. Engr. 431. Mechanics, Selection and Service of Machinery. 0-0-4

Prerequisites: Agr. Engr. 331, 332, E.M. 311.

A study of mechanics involved in tractor and machinery design and operation, static and dynamic stability of tractors, belt and drawbar efficiency, Nebraska Tractor Tests, capacity, and standardization, operation and management of Dealer Service Shop.

Mr. Giles.

Agr. Engr. 441. Soil and Water Conservation II. 3-0-0

Prerequisites: Agr. Engr. 341, C.E. 203.

Factors affecting erosion, methods of controlling erosion, land-use classification, drainage and land clearing, irrigation methods, design requirements for portable irrigation systems, economic aspects of irrigation in the Southeast.

Mr. Wilson.

Agr. Engr. 451. Farm Structures Design. 0-0-3

Prerequisite: Agr. Engr. 351.

The design of walls and wall coverings to impair the transfer of heat and moisture. The design of building elements and their connections to withstand the imposed loads.

Staff.

Agr. Engr. 462. Rural Electrification II. 0-3-0

Prerequisite: Agr. Engr. 362.

Lecture and laboratory work on materials and design for rural distribution lines; switches and controls; heat and refrigeration; poultry and dairy equipment; special application of electricity to farm processes.

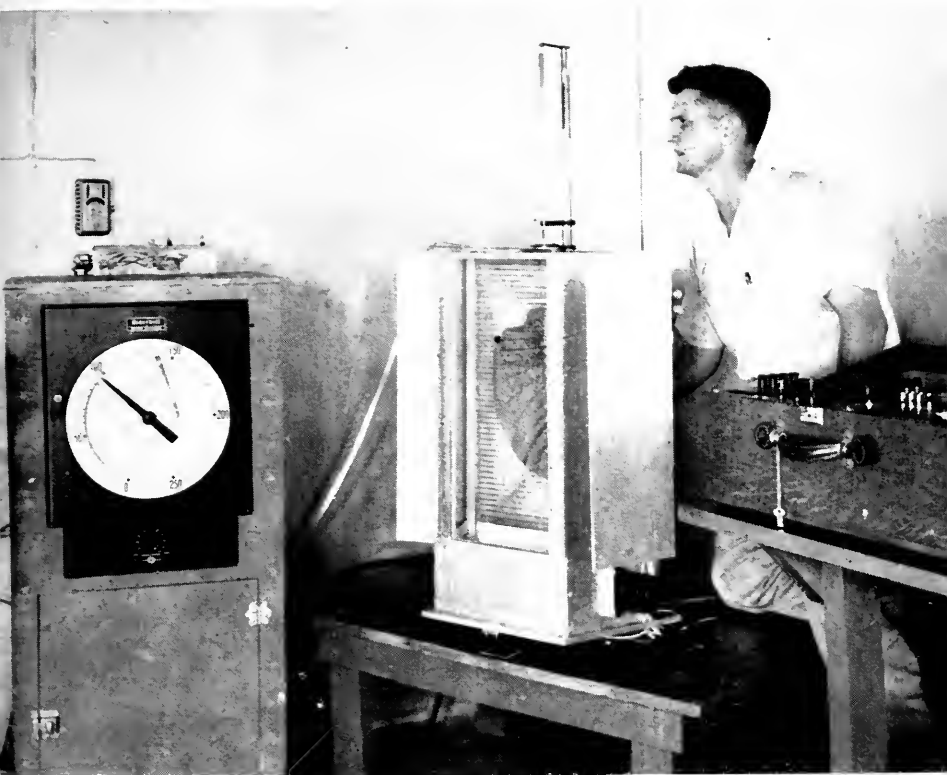
Mr. Weaver.

Courses for Advanced Undergraduates and Graduates

Agr. Engr. 501, 502, 503. Special Problems in Agricultural Engineering. 3-3-3

Prerequisites: 10 credits in selected option.

For students who desire advanced work in one of the following subjects: Farm Engines, Tractors, Farm Mach., Buildings, Conveniences, Rural Electrification, Erosion Control and Drainage. Staff.



Research in the Fundamentals of Tobacco Curing.

Agr. Engr. 531. Farm Machinery Design.

0-3-0

Prerequisites: Agr. Engr. 431, M.E. 321, E.M. 321.

Development and design methods and procedures as used in public research agencies and industry. A study of elements and materials, their application, selection and design in farm machines. Design layout and production methods.

Staff.

Courses for Graduates Only

Agr. Eng. 601. Research in Agricultural Engineering

Credits by arrangement

A maximum of nine credits is allowed toward the Master's degree, but any number toward the Doctorate.

Staff.

Prerequisites: Graduate standing in Agr. Eng., Any Option.

Research in specialized phases of Agr. Eng.

Agr. Eng. 604. Seminar

Credits by arrangement

A maximum of three credits is allowed toward the Master's degree, but any number toward the Doctorate.

Staff.

Prerequisites: Grad. standing in Agr. Eng., Any Option.

Scientific Articles, Progress Reports in Research, and special problems of interest to Agricultural Engineers will be assigned, reviewed and discussed by students and members of the Agr. Eng. Staff.

Agr. Eng. 641. Advanced Drainage, Irrigation and

Erosion Control.

0-0-5

Prerequisites: Grad. standing in Agr. Eng., Land Improvement Option.

An advanced study of the more complex problems in Drainage, Irrigation and Erosion Control methods.

Mr. Wilson.

Agr. Eng. 651. Advanced Farm Structures.

0-5-0

Prerequisites: Grad. standing in Agr. Eng., Rural Structures Option.

A more advanced study of the problems of Farm Structures that is given in courses Agr. Eng. 322 and Agr. Eng. 423.

Staff.

DEPARTMENT OF AGRONOMY

Graduate Faculty

Professors: WILLIAM EARLE COLWELL, Head, JAMES WALTER FITTS, WALTON CARLYLE GREGORY, NATHAN SCOTT HALL, PAUL H. HARVEY, JAMES FULTON LUTZ, GORDON KENNEDY MIDDLETON, WERNER LIND NELSON, JOSEPH ARTHUR WEYBREW, WILLIAM WALTON WOODHOUSE, JR., WILLIE GARLAND WOLTZ, E. TRAVIS YORK, JR.

Associate Professors: NATHANIEL TERRY COLEMAN, GLENN CHARLES KLINGMAN, CLAYTON DOYLE MCAULIFFE, THURSTON JEFFERSON MANN, ADOLPH MEHLICH, EILIF V. MILLER, PHILIP ARTHUR MILLER, CORNELIUS H. M. VAN BAVEL.

Assistant Professors: DOUGLAS SCALES CHAMBLEE, DAN ULRICH GERSTEL, STANLEY BERT MCCAULEY.

The Department of Agronomy offers training leading to the degrees of Master of Science and Doctor of Philosophy in the following fields: Plant Breeding, Crop Production, Weed Control, Soil Science, Chemistry, Fertility, Physics, and Genesis.

Facilities—The Department of Agronomy is housed in Williams Hall, a large, modern building which provides excellent facilities for graduate training. In addition to the office and laboratory space assigned each student, numerous other facilities are available for use in carrying on a program of graduate study. These include special preparation rooms for soil and plant samples, cold storage facilities for plant material, air conditioned rooms for studying physical properties of the cotton fiber and of the tobacco leaf, soil and plant analytical service laboratories and radioactive and stable isotope laboratories. A departmental library is equipped with books, periodicals and bibliographic material dealing with agronomic and closely related subjects. A seminar room (with adjoining kitchen) is equipped with comfortable chairs and provides a pleasant atmosphere for special conferences and for the exchange of ideas in departmental seminar programs. Four ranges of greenhouses situated at the rear of Williams Hall are provided with benches, tables, ground beds, lights and other necessary equipment. An area in close proximity to Williams Hall is set aside for concrete frames, tiles and other outdoor equipment. A total of 16 farms are owned or operated by the state for research investigations. These farms are located throughout the state to include a wide variety of soil and climatic conditions needed for experiments in soils, plant breeding and crop management.

Supporting Departments—Strong supporting departments greatly increase the graduate students' opportunities for a broad and thorough training. Included among those departments in which graduate students in agronomy work cooperatively or obtain instructions are Botany, Chemistry, Genetics, Geology, Mathematics, Plant Pathology, Physics and Statistics.

Opportunities—In North Carolina, a state which derives 80% of its agricultural income from farm crops, the opportunities for the well-trained agronomist are exceedingly great. The recipients of advanced degrees in Agronomy at North Carolina State College are found in positions of leadership in research and education throughout the nation and the world where, through their technological training, they continue to contribute to the betterment of agriculture.

Courses for Advanced Undergraduates

AGRONOMY

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|---|--|
| <p>Agron. 401. Soil Management.
 Prerequisite. Agron. 301.
 Principles of soil management and factors affecting soil productivity.</p> | <p>0-3-0

 Mr. Nelson.</p> |
| <p>Agron. 411. Crop Production II: Tobacco and Cotton.
 Prerequisites: Agron. 201.
 A study of tobacco and of cotton production from the standpoints of botany and growth characteristics, seeding practices, cropping systems, mineral nutrition, field care, varieties, harvesting, processing, elements of quality and factors influencing quality, and uses of the crop.</p> | <p>0-4-0

 Mr. Colwell.</p> |
| <p>Agron. 412. Pastures and Forage Crops.
 Prerequisites: Agron. 101 and Agron. 201.
 A study of the production and preservation of the principal forage crops. Special attention is given to the development and maintenance of pastures.</p> | <p>0-0-4

 Mr. Chamblee.</p> |



Four ranges of well-equipped greenhouses and a two-story headhouse at the rear of Williams Hall provides excellent facilities for greenhouse research studies in the various phases of agronomy.

Agron. 413. Plant Breeding.

0-3-0

Prerequisite: Gen. 411.

The application of genetic principles to crop improvement.

Mr. Mann.

Agron. 414. Weeds and Their Control.

0-0-3

Prerequisite: Chem. 203 or equivalent, Agron. 101 and 102.

Principles involved in cultural and chemical weed control. Practice in identification of plants and seeds.

Mr. Klingman.

Courses for Advanced Undergraduates and Graduates

Agron. 501. Soil Fertility Evaluation.

4-0-0

Prerequisite: Agron. 301, Chem. 211.

Analysis for available elements in the soil; the use of soil and plant analysis in soil diagnosis.

Mr. Fitts.

Agron. 502. Soil Chemistry.

0-4-0

Prerequisites: Agron. 301 and Chem 212.

Chemical composition and properties of soil, particularly concerning clay mineralogy, chemical processes of weathering, soil solution reactions, chemical properties of clays and ionic exchange in soils.

Mr. McAuliffe.

Agron. 503. Soil Physics.

4-0-0

Prerequisites: Agron. 201 and Phys. 201.

Physical constitution and analysis; structure, water relations, soil air and temperature in relation to plant nutrition.

Mr. Lutz.

Agron. 504. Soil Microbiology.

0-0-3

See Botany 551.

Agron. 512. Advanced Plant Breeding II.

0-0-3

Prerequisites: Gen. 512.

Lectures on methods and principles of plant breeding.

Staff.

Agron. 521, 522, 523. Special Problems.

Credits by arrangement

Prerequisite: Admitted only with consent of instructor.

Special problems in various phases of agronomy. Problems may be selected or will be assigned. Emphasis will be placed on review of recent and current research.

Staff.

Courses for Graduates Only*

Agron. 601. Soil Development.**

4-0-0

Prerequisite: Graduate standing in soils.

Genesis, morphology, and development of the great soil groups of the world.

Mr. McCaleb.

Agron. 602. Advanced Soil Fertility.**

0-0-3

Prerequisite: Agronomy 301. Graduate standing in soils.

Soil conditions affecting crop growth; the chemistry of soil and plant interrelationships; theoretical and applied aspects of fertilizer usage in relation to plant nutrition.

Mr. Nelson.

*Students are expected to consult the instructor before registration.

**Offered in 1952-53 and in alternate years.

Agron. 603. Physical and Colloidal Chemistry of Soils.**

0-0-5

Prerequisite: Graduate standing.

The origin and nature of inorganic and organic soil colloids. The application of principles of physical and colloidal chemistry to soils problems. Current literature in soil chemistry.

Mr. Coleman.

Agron. 604. Advanced Soil Physics.***

0-5-0

Prerequisites: Agron. 503, Math. 401, and Phys. 201-203.

An introduction into the usage of theoretical methods in soil physics. Lectures, literature, and discussions centered around problems in potential flow involving soil water, soil gasses, and energy.

Mr. van Bavel.

Agron. 611. Forage Crop Ecology.**

0-3-0

Prerequisites: Agron. 412 and Botany 441.

A study of the effect of environmental factors on the growth of forage crops. Attention will be given to methods of research in forage crop ecology.

Mr. Chamblee.

Agron. 631. Seminar.

One credit per term

Prerequisite: Graduate standing in Agronomy.

Scientific articles, progress reports in research, and special problems of interest to agronomists reviewed and discussed.

A maximum of three credits is allowed toward the Master's degree but any number toward the Doctorate.

Graduate Staff.

Agron. 641. Research.

Credits by arrangement

Prerequisite: Graduate standing in Agronomy.

A maximum of nine credits is allowed toward the Master's degree but any number toward the Doctorate.

Graduate Staff.

DEPARTMENT OF ANIMAL INDUSTRY

Graduate Faculty

Professors: DEAN WALLACE COLVARD, Head, JOHN LINCOLN ETCHELLS, EARL HENRY HOSTETLER, WILLIAM MILNER ROBERTS, FRANCIS WEBBER SHERWOOD, MARVIN LUTHER SPECK, HAMILTON ARLO STEWART, ROBERT KENNETH WAUGH, GEORGE HERMAN WISE.

Associate Professors: ELLIOTT ROY BARRICK, JAMES EDWARD LEGATES, GENNARD MATRONE, JOHN CLARK OSBORNE, FRANK HOUSTON SMITH, FREDERICK GAIL WARREN.

Assistant Professors: LEONARD WILLIAM AURAND, ROBERT BARNES CASSADY, LEMUEL GOODE, SAMUEL B. TOVE.

The Department of Animal Industry offers M.S. and Ph.D. degrees in the fields of Animal Nutrition, Dairy Manufacturing, Dairy Husbandry, Animal Husbandry and Animal Physiology. Candidates for advanced degrees in Dairy Husbandry may select options dealing with dairy cattle breeding, dairy cattle nutrition, and other phases of Dairy Husbandry. Likewise, degrees in Animal Husbandry may be obtained in meat preservation and processing, in animal breeding, animal nutrition and in other phases of Animal Husbandry. Degrees in the field of Dairy Manufacturing may be

***Offered in 1953-54 and in alternate years.

obtained in dairy bacteriology, dairy chemistry, and dairy plant efficiency and management.

Within the Department of Animal Industry, as well as in cooperation with other departments such as Poultry, Statistics, and Chemistry, specialized subject matter groups have been developed to direct graduate work in fields such as Genetics and fundamental phases of Animal Nutrition.

Men who have received their graduate training in the Department of Animal Industry have found employment in other educational and research institutions, in dairy processing, feed manufacturing and meat processing industries as well as in a number of other fields. The department is equipped to provide leadership for 35 to 40 graduate students and to date demands for services of trained men in these fields have far exceeded the number which has been available.

The department operates approximately 2,000 acres of land in order that animals of various types and breeds may be available for research. In addition, branch stations are located in all major geographic areas of the state so that the research program may be applied to the conditions existing throughout the state. The Animal Industry Research Center which is located adjacent to the campus serves as an intermediary between the farms and the laboratories on the campus. At this Research Center digestion trials, animal disease research and many phases of the physiology and nutrition programs are conducted. In addition, a physiology laboratory and bull barn, with stalls for 20 bulls and with temperature control chambers, is used for research in physiology of reproduction and heat tolerance.

On the campus the Animal Industry Department is housed in Polk Hall, which is devoted entirely to laboratories, classrooms, and offices as well as to accommodate modern ^{dairy plant} creamery and meat processing laboratories.

Every effort is made to provide an opportunity for the graduate students to explore the fundamental principles of livestock production and processing. The graduate student roster is composed of men and women from many states and several countries, and likewise the staff is composed of men who received their training at various institutions.

Opportunities Courses for Advanced Undergraduates

A.I. 421. Animal Industry Seminar.

Max. 3

Review and discussion of special topics and the current literature pertaining to all phases of Animal Production.

Messrs. Colvard, Hostetler, Waugh.

A.I. 441. Pork Production.

4-0-0

A study of types, breed characteristics, and adaptability of swine. Emphasis is given to breeding, housing and marketing swine. Practical work is given in feeding, management and judging.

Messrs. Stewart, Barrick.

A.I. 442. Beef Cattle Production.

0-4-0

A study of modern methods of feeding, care, and management of the beef herd. Special attention will be given to feed-lot operations and selection of animals.

Messrs. Barrick, Goode.

A.I. 443. Dairy Production II.

0-0-3

Prerequisite: A.I. 343.

A continuation of A.I. 343. This course is a more advanced study of practical management of the dairy farm operations including farm sanitation, relationship of disease to management, losses due to sterility, culling of herds, interpretation of cow performance, barn types, etc.

Mr. Murley.

A.I. 444. Sheep Production.

0-0-3

A study of the methods used in producing lamb and wool. Principles and practices underlying economical production of sheep, including a study of the breeds and their adaptability. Breeding, feeding, and management of purebred and commercial flocks. Mr. Goode.

A.I. 462. Diseases of Farm Animals.

0-4-0

Prerequisites: Botany 312 and Zool. 201.

Etiology and symptoms of infectious, non-infectious, and parasitic diseases of farm animals. Methods of spread of common infectious diseases with especial emphasis upon economic losses and methods of prevention, control, and eradication of the major diseases of farm animals. Messrs. Grinnells, Osborne.

Courses for Advanced Undergraduates and Graduates

A.I. 501. Topical Problems in Animal Industry.

Max. 9

Staff.

A.I. 502. Animal Breeding.

0-4-0

Prerequisite: Gen. 411.

Physiology of reproduction and the mode of inheritance of important characteristics in farm animals. Origin, history, and adaptability of the breeds of livestock. Special emphasis on the place of selection, artificial insemination, inbreeding, and crossbreeding in an overall program of animal improvement. Messrs. Stewart, Legates.

A.I. 513. Animal Nutrition II—Nutrient Utilization.

0-0-4

Prerequisite: A.I. 312.

Methods of measuring the metabolism of nutrients and their utilization in maintenance and production. Mr. Wise.

A.I. 522. Physiology of Domestic Animals.

0-4-0

Prerequisite: Zool. 301.

An applied course in advanced physiology of domestic mammals, with special reference to the farm animals. Messrs. Casady, Myers.

A.I. 533. Physiology of Reproduction.

0-0-3

Prerequisite: A.I. 522.

Reproductive anatomy with a detailed study of the physiological process involved in reproduction, with special reference to farm mammals. Lectures and laboratory exercises including artificial insemination of farm animals. Messrs. Casady, Myers.

A.I. 534. Physiology of Lactation.

0-0-2

Prerequisite: A.I. 522.

The anatomy and physiology of the mammary gland with special reference to factors controlling and influencing the amount of composition of milk. Mr. Casady.

A.I. 562. (See Chem. 562.) Biochemistry of Lipides.

0-3-0

Prerequisites: Chem. 203 or 421, 422, 423.

Distribution, classification, chemistry, and metabolism of the lipides.

Messrs. Nevin and Smith.

Courses for Graduates Only

A.I. 611. Animal Nutrition: Mineral Metabolism.

3-0-0

The role of minerals in the nutrition of animals.

Mr. Matrone.

A.I. 621. (See Chem. 621.) Enzymes.

4-0-0

Prerequisites: Chem. 423 or 452.

The kinetics, measurements and nature of enzyme action; specific enzymes, coenzyme-enzyme-substrate systems and intermediary metabolism cycles.

Mr. Tove.

A.I. 623. (See Chem. 623.) Biological Assay of Vitamins.

0-0-4

Prerequisites: A.I. 312 or Chem. 452; Stat. 412.

Techniques and designs of biological assays for vitamins. Validity tests and methods for computing potency and confidence limits are emphasized.

Mr. Sherwood.

***A.I. 626. Advanced Animal Breeding.**

0-0-3

Prerequisite: Stat. 625.

Review and appraisal of contemporary research in animal breeding.

*Offered in alternate years starting with 1953.

Mr. Legates.

A.I. 631. Research in Animal Industry.

Credits by arrangement

A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs.

Staff.

BOTANY

A UNIT OF THE DIVISION OF BIOLOGICAL SCIENCES

Graduate Faculty

Professors: HERBERT TEMPLE SCOFIELD, Head, DONALD BENTON ANDERSON, BERTRAM WHITTIER WELLS.

Associate Professors: ERNEST BALL, LARRY ALSTON WHITFORD.

Assistant Professors: HAROLD J. EVANS, WILLIAM BASIL FOX*, ROBERT KENNETH GODFREY.

Botany offers work leading to the Master of Science degree in the special fields of plant physiology, ecology, anatomy, morphology, and systematic botany. Graduate work in preparation for the Doctorate is offered in the fields of plant physiology and ecology.

The Botany Faculty is provided with excellent facilities for teaching and research. Ample laboratory space and equipment for graduate study in all phases of botany are featured. Of special note are the excellent laboratory and greenhouse facilities for research in plant physiology, particularly mineral nutrition, and the rapidly growing herbarium which supports study in systematics and ecology. The reasonably close location of the coast, coastal plain, piedmont and mountains gives a wide variety of vegetational types of importance to research in ecology and systematic botany. The faculty, its facilities and its geographical location should prove very attractive to those interested in graduate study in botany.

Graduate students terminating their work at the Masters level have a somewhat limited opportunity as professional botanists. State and Federal employment is available as well as teaching positions in small colleges and secondary schools. Those achieving the Ph.D. degree, however, will find opportunities for teaching positions in colleges and universities, for research positions in federal and state Experiment Stations, and for research and development work in botanical fields with private industry or research institutions.

* Deceased 1952.

Courses for Advanced Undergraduates

- Bot. 410. Plant Microtechnique** 3-0-0
 Prerequisites: Bot. 101, 102, and Chem. 203.
 Methods of preparation of plant structures for microscopic examination. Mr. Ball.
- Bot. 412. General Bacteriology.** 4 or 4 or 4
 Prerequisites: Bot. 101, 102, or Zool. 101.
 An introduction to the principles of bacteriology; laboratory work on modern cultural methods of handling and studying bacteria. Mr. Peterson.
- Bot. 421. Plant Physiology.** 5-0 or 5
 Prerequisites: Bot. 101, 102, and Chem. 203.
 The activities of living plants with special emphasis upon the fundamental principles concerned. Messrs. Anderson, Scofield.

Courses for Advanced Undergraduates and Graduates

- Bot. 511. Morphology of Non-Vascular Plants.** 0-0-3
 Prerequisites: Bot. 101, 102, 203.
 Comparative morphology, ontogeny and evolution of the major groups of non-vascular plants. Mr. Ball.
- Bot. 512. Morphology of Vascular Plants.** 0-3-0
 Prerequisites: Bot. 101, 102, 203.
 Comparative morphology, ontogeny and evolution of the major groups of vascular plants. Mr. Ball.
- Bot. 513. Plant Anatomy.** 0-0-3
 Prerequisites: Bot. 101, 102, 203.
 Anatomy of Gymnosperms and of Angiosperms is emphasized. Comparative growth and structure of meristems. Development and mature structure of cell types, tissues, stem, root, and leaf. Mr. Ball.
- Bot. 521. Systematic Botany of Grasses.** 3-0-0
 Prerequisite: Bot. 203.
 Identification and classification of common species. Mr. Wells.
- Bot. 523. Systematic Botany of Dicot Families.** 0-0-3
 Prerequisite: Bot. 203.
 Identification, classification and economic significance of important families such as Leguminosae, Rosaceae, and Solanaceae. Mr. Fox.
- Bot. 532, 533. Advanced Plant Physiology.** 0-3-3
 Prerequisites: Bot. 101, 102, 421.
 A critical and comprehensive treatment of the various aspects of plant physiology; particular attention given to basic principles and to recent developments. Messrs. Anderson, Scofield.
- Bot. 535. Research Methods in Plant Physiology.** 0-3-0
 Prerequisite: Bot. 421.
 A review of certain methods and techniques in use in physiological research; laboratory experience in the use of some of those peculiar to plant physiology. Mr. Scofield.

Bot. 537. Microanalysis of Plant Tissue. 0-3-0

Prerequisites: Bot. 101, 102, 421.

The identification in plant tissues of mineral elements and organic compounds and the physiological significance of these materials.

Mr. Anderson.

Bot. 541. Plant Ecology. 3-0-0

Prerequisites: Bot. 101, 102, 421.

Environmental control of plant distribution with emphasis upon the habitats and vegetation of North Carolina.

Mr. Wells.

Bot. 551. Soil Microbiology. 0-0-3

Prerequisites: Bot. 101, 102, 412, 421.

The more important microbiological processes that occur in soils: decomposition of organic materials, ammonification, nitrification, and nitrogen fixation.

Bot. 552. Advanced Bacteriology. 0-3-0

Prerequisites: Bot. 101, 102, 412.

A comprehensive treatment of the fundamentals of bacteriology. Methods used in bacteriological analysis of water.

Bot. 573. Aquatic Botany. 0-0-3

Prerequisites: Bot. 101, 102.

Collection and identification of the important species of aquatic plants of the region and a study of their environmental relations. Emphasis is on the fresh-water algae.

Mr. Whitford.

Courses Limited to Graduate Students

Bot. 611, 612, 613. Bacteriology: Special Studies. 3-3-3

Prerequisites: Bot. 412, 552.

Special work on restricted groups of bacteria, such as nitrogen bacteria of the soil, milk organisms, and special groups of bacteria in water.

Bot. 621. Systematic Botany: Special Studies. 3-0-0 or 0-0-3

Prerequisite: Bot. 203.

An advanced survey of restricted groups of plants involving organization and distribution problems.

Messrs. Wells, Fox, Godfrey.

Bot. 631, 632, 633. Plant Physiology: Special Studies. 3-3-3

Prerequisites: Bot. 421, 532.

Critical study of some particular problem, involving original investigation together with a survey of pertinent literature.

Messrs. Anderson, Scofield.

Bot. 635. The Mineral Nutrition of Plants. 0-3-0

Prerequisites: Bot. 421.

A treatment of the principles involved in the mineral nutrition of plants with particular emphasis upon the factors concerning nutrient absorption and the functions and interrelations of the mineral elements in the biochemical processes of plant metabolism.

Mr. Evans.

- Bot. 641. Advanced Plant Ecology. 0-0-3
Prerequisites: Bot. 421, 541.
Practice in the use of the instruments necessary in the study of environmental factors; advanced readings and conferences on plant distribution in relation to these factors. Mr. Wells.
- Bot. 642, 643, 644. Plant Ecology: Special Studies. 3-3-3
Prerequisites: Bot. 203, 541.
Minor investigations in vegetation-habitat problems accompanied by advanced reference reading. Mr. Wells.
- Bot. 651. Research. Credits by arrangement
Prerequisite: Graduate standing in Botany.
A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs. Staff.
- Bot. 661. Seminar. One credit per term
Prerequisite: Graduate standing.
Attendance at weekly meetings and presentation of one paper during each term registered.
A maximum of three credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs. Staff.

DEPARTMENT OF CERAMIC ENGINEERING

Graduate Faculty

Professors: WILLIAM WURTH KRIEGLER, Head, WILLIAM CALLUM BELL.
Associate Professor: CHARLES VICTOR RUE.

The Department of Ceramic Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees in Ceramic Engineering.

Graduate study and research may be pursued in the following subdivisions: electrical ceramics, glass, vitreous enamels and coatings, structural clay products, refractories and whitewares (wall tile, sanitary ware, dinnerware, etc.).

The prerequisite for a major in ceramic engineering graduate work is a proficiency in the undergraduate courses required for the Bachelor's degree in ceramic engineering, or substantial equivalent.

The laboratories of the department are well equipped to enable carrying forward of researches in the areas previously mentioned. These facilities are augmented by those of the Ceramic Research Laboratories of the Department of Engineering Research. Also available are the Electron Microscope and X-Ray Diffraction Laboratories of that Department.

Illustrative of the scope of graduate research in ceramics at North Carolina State College are some of the recent and current projects. These have encompassed studies of the dielectric and physical characteristics of ceramic bodies in the system $\text{BaTiO}_3\text{-BaCeO}_3$, studies of the power losses in low dielectric constant ceramics, the effect of devitrification of the glassy phase on the conductivity of ceramic insulator bodies, studies of spodumene, tremolite talc and nepheline syenite in multicomponent vitreous bodies, dielectric studies of cordierite bodies, high temperature load bearing characteristics

of silica-clay refractories, the effect of alkali on the hygroscopicity of glass, studies of the maximum safe rates of drying structural clays and the pozzolanic properties of shale.

Fellowships

Two types of fellowships are available to graduate students in Ceramic Engineering. The Edward Orton Jr. Ceramic Foundation Fellowship and the Western North Carolina Ceramic Minerals Fellowship permit full time to be devoted to graduate studies. The College fellowships permit half time studies and half time to be devoted to assigned teaching or research duties. Applications should be made to the Department.

Courses for Advanced Undergraduates

- Cer. E. 403. Silicates I.** 0-0-3
Required of Juniors in Ceramic Engineering.
Prerequisites: Chem. 332 and Cer. E. 302.
The fundamental principles underlying the composition and production of whitewares, cements, and plasters. Mr. Rue.
- Cer. E. 404. Silicates II.** 3-0-0
Required of Seniors in Ceramic Engineering.
Prerequisites: Chem. 332 and Cer. E. 302.
The fundamental principles underlying the composition and production of glazes, glasses and porcelain enamels. Mr. Rue.
- Cer. E. 405. Silicates III.** 0-3-0
Required of Seniors in Ceramic Engineering.
Prerequisites: Chem. 332 and Cer. E. 302.
The fundamental principles underlying the composition, production and uses of refractories and abrasives. Mr. Kriegel.
- Cer. E. 411, 412. Ceramic Laboratory II.** 2-2-0
Required of Seniors in Ceramic Engineering.
A laboratory course coordinated and concurrent with Cer. E. 404, 405. Staff.
- Cer. E. 413. Senior Thesis.** 0-0-3
Required of Seniors in Ceramic Engineering.
Prerequisite: Cer. E. 412.
Special problem involving independent laboratory investigation in some phase of ceramic engineering. Final report to be submitted in the form of a thesis. Staff.
- Cer. E. 415, 416, 417. Ceramic Engineering Design.** 3-3-3
Required of Seniors in Ceramic Engineering.
Prerequisite: Cer. E. 302.
The design of ceramic equipment and structures. Messrs. Kriegel, Rue.

Courses for Graduates and Advanced Undergraduates

- Cer. E. 503. Ceramic Microscopy.** 0-0-3
Prerequisite: Geol. 532.
Petrographic techniques for the systematic study of ceramic materials. Interpretation and representation of results. Mr. Rue.
- Cer. E. 506. Advanced Studies in Drying.** 0-3-0
An advanced course on the mechanism of drying ceramic solids; heat balance and principles of operation of commercial driers. Mr. Rue.
- Cer. E. 511. Advanced Studies in Firing.** 0-0-3
An advanced course in fuel and heat requirements, thermal behavior, selection and operation of commercial kilns as related to the firing of ceramic products. Mr. Rue.

Cer. E. 517, 518, 519. Advanced Ceramic Experiments.	3-3-3
Prerequisite: Cer. E. 413 or equivalent.	
Advanced studies in ceramic laboratory experimentation.	Staff.

Courses for Graduates Only

Cer. E. 601. Ceramic Chemistry.	3-0-0
Chemical and physical properties of ceramic materials; physiochemical reactions in the manufacture of ceramic products.	Mr. Rue.
Cer. E. 613. Ceramic Thermal Mineralogy.	0-0-3
Prerequisite: Cer. E. 601.	
Application of the principles of thermo-chemical mineralogy to ceramic problems.	Mr. Bell.
Cer. E. 616. Silicate Crystal Structures.	0-3-0
Prerequisite: Phys. 407.	
Basic laws of crystal chemistry; classification of the silicates, relation of physical properties to crystal-structure.	Mr. Kriegel.
Cer. E. 620. Ceramic Research.	3 to 9
Prerequisite: Graduate standing in ceramic engineering.	
An original and independent laboratory investigation in some phase of ceramics will be assigned to meet the desire of the student for specialization. A report of such an investigation is required as a graduate thesis.	Staff.
Cer. E. 621. Ceramic Engineering Seminar. One credit per term.	1-1-1
Prerequisite: Graduate standing in ceramic engineering.	
Reports and discussion of problems in ceramic engineering. A maximum of 3 credits is allowed towards the Master's degree but any number toward the Doctorate.	Staff.
Cer. E. 632, 633. Structural Clay Products.	0-3-3
Advanced technology of structural clay materials and their use.	Kriegel.
Cer. E. 635, 636. Refractories.	3-3-0
Advanced technology of refractory materials and their use.	Mr. Kriegel.
Cer. 639, 640. Whitewares.	3-3-0
Advanced technology of whiteware bodies and glazes.	Mr. Rue.
Cer. E. 644, 645. Ceramic Colors and Enamels.	0-3-3
Technological principles underlying the composition and production of ceramic colors and enamel coatings.	Mr. Kriegel.
Cer. E. 647, 648. Glass Technology.	3-3-0
Theories concerning the constitution of the vitreous state; multi-component equilibria involved in commercial glass compositions; correlation of the structural, physical and chemical behavior of the glass-making oxides with the properties of glasses.	Mr. Kriegel.

Cer. E. 661, 662, 663. Special Studies in Ceramic Engineering.

3-3-3

Open only to candidates for the doctorate.

Special studies of advanced topics in ceramic engineering.

Graduate Staff.

Cer. E. 672. Advanced Ceramic Thermal Mineralogy.

0-3-0

Prerequisite: Cer. E. 613.

0-3-0

Application of the principles of thermo-chemical mineralogy to the more complex systems.

Mr. Bell.

DEPARTMENT OF CHEMICAL ENGINEERING

Graduate Faculty

Professors: EDWARD MARTIN SCHOENBORN, Head, KENNETH ORION BEATTY, JR., FREDERICK PHILIPS PIKE.

Associate Professor: RUSSELL FRANK HAZELTON.

The department offers programs of advanced study and research leading to the Master of Science and Doctor of Philosophy degrees. Currently, between twenty and twenty-five graduate students are in residence of which approximately one-third are working toward the doctorate. The department comprises a highly competent staff of nine full-time personnel which seeks to provide for intimate association between it and its students, to promote a common interest in advanced professional study, and to encourage intensive investigation and creative activity of a high order.

For those who can qualify, graduate work in chemical engineering is of increasing importance since it enables the student to attain a higher degree of specialized professional competence and at the same time to secure greater mastery of the sciences which underlie the quantitative aspects of chemical technology. The demand for chemical engineers with advanced training is greater now than at any time since the birth of the great chemical industry. In fact, the number and variety of challenging opportunities is steadily increasing, especially in the South which is rapidly becoming the new industrial frontier. The recent high concentration of industries producing synthetic fibers and other materials within a radius of several hundred miles of the College is but one example of this development.

Students having had one or more years of training beyond the baccalaureate are especially needed for fundamental and applied research, for process development and design, for production, and even for management, technical service and sales. Private consulting work and careers in teaching usually demand a period of advanced study well beyond the normal four-year undergraduate program.

At present, major emphasis in the department is concerned with basic studies of unit operations such as fluid flow, heat transfer at high and low temperatures, distillation, solvent extraction, etc., with thermodynamics, reaction kinetics, phase equilibria, plastics technology, process measurement and control, and many other aspects of chemical technology. A new laboratory devoted exclusively to the study of thermal properties of materials provides unique facilities for graduate work in this important field. Strong supporting programs of work are also available in mathematics, statistics, physics, chemistry, nuclear engineering, metallurgy, the life sciences, textiles, and in other fields of engineering.

The Department of Chemical Engineering occupies the entire four-story east wing of the new Riddick Engineering Laboratories building. Modern, well-equipped laboratories are provided with all necessary services for both teaching and research. A wide variety of special facilities such as X-ray equipment, spectrophotometers, electron microscope, electro-mechanical testing machine, electronic controllers and recorders, etc. are available for graduate research.

Fellowships and Assistantships

In cooperation with the Department of Engineering Research, members of the chemical engineering staff are engaged in conducting a number of important research projects which are supported by industry, and by State and governmental agencies. Graduate students assisting on these projects not only acquire financial assistance but gain valuable research experience on problems of current interest.

In addition to research assistantships, the department also offers each year a limited number of graduate assistantships or fellowships for part-time work in the department. These may be for teaching, laboratory preparation, etc. or for research, as the need arises. Appointments are for one academic year of nine months for half-time work and at the present carry a stipend of \$1,200. They are renewable upon evidence of satisfactory performance.

Courses for Advanced Undergraduates

- Ch. E. 411, 412. Unit Operations II and III. 3-3-0
 Prerequisite: Ch. E. 313.
 Required of seniors in Chemical Engineering.
 A continuation of Ch. E. 313. Theory and methods of calculation involved in distillation, absorption, drying, size separation, filtration, etc. Mr. Pike.
- Ch. E. 415. Chemical Engineering Thermodynamics II. 3-0-0
 Prerequisite: Ch. E. 315.
 Required of seniors in Chemical Engineering.
 A continuation of Ch. E. 315. Thermodynamic properties, chemical reaction equilibria, vaporization and condensation equilibria, etc. Mr. Beatty.
- Ch. E. 431, 432, 433. Unit Operations Laboratory I, II, III. 3-3-3
 Prerequisite: Ch. E. 313; concurrent, corresponding lecture course.
 Required of seniors in Chemical Engineering.
 Laboratory work on typical apparatus involving the unit operations. Experiments are designed to augment the theory and data of the lecture courses and to develop proficiency in the writing of technical reports. Staff.
- Ch. E. 453. Chemical Processing of Radioactive Materials. 0-0-3
 Prerequisite: Phys. 407.
 Consideration of the unique procedures required for the bulk manipulation of radioactive chemicals. Particular attention is given to remote operational procedures of precipitation, centrifugation, conveying, solvent extraction and ion exchange. Design of apparatus involving low maintenance and ease of replacement and cleaning by safe methods is considered. Other topics include decontamination procedures and disposal of wastes. Mr. Pike.
- Ch. E. 461, 462, 463. Seminar. 1-1-1
 Prerequisite: Senior standing.
 Elective for seniors in Chemical Engineering.
 Literature survey of selected topics in chemical engineering. Emphasis on oral and written presentation. Staff.

Prerequisite: Ch. E. 313.

Two terms required of seniors in Chemical Engineering.

Introduction to research through experimental, theoretical and literature studies of chemical engineering problems. Oral and written presentation of reports. Staff.

Courses for Graduates and Advanced Undergraduates

Ch.E. 525. Process Measurement and Control.

3 or 3 or 3

Prerequisite: Ch.E. 313.

Theory and application of methods for measuring, transmitting, recording and controlling such process variables as temperature, pressure, flow rate, liquid level, concentration, humidity, etc. Commercial instruments are utilized for study of a wide variety of industrial control problems. Recorder-controllers are available for simulating industrial control problems of varying difficulty.

Mr. Finch.

Ch. E. 527. Process Engineering.

0-0-4

Prerequisite: Ch. E. 412.

Required of seniors in Chemical Engineering.

A study of selected chemical processes with emphasis on the engineering, chemical and economic factors involved.

Mr. Pike.

Ch. E. 540. Electrochemical Engineering.

3 or 3 or 3

Prerequisite: Physical Chemistry.

Elective for seniors in Chemical Engineering.

The application of electrochemical principles to such topics as electrolysis, electroanalysis, electroplating, metal refining, etc.

Mr. Schoenborn.

Ch. E. 541. Cellulose Industries.

3 or 3 or 3

Prerequisite: Chem. 426.

Methods of manufacture and application of cellulose chemical conversion products. Emphasis placed on recent developments in the fields of synthetic fibers, films, lacquers, and other cellulose compounds.

Mr. Seely.

Ch. E. 542. Technology of Pulp and Paper.

3 or 3 or 3

Prerequisite: Chem. 426 or equivalent.

Fundamentals of pulp and paper manufacture with emphasis on recent advances in the field.

Mr. Seely.

Ch. E. 543. Technology of Plastics.

3 or 3 or 3

Prerequisite: Chem. 426 or equivalent.

The properties, methods of manufacture, and applications of synthetic resins. Recent developments in the field are stressed.

Mr. Seely.

Ch. E. 544. Fuels and Combustion.

3 or 3 or 3

Prerequisite: Ch. E. 312.

Solid, liquid and gaseous fuels; fundamentals of combustion with application to design and use of industrial equipment.

Mr. Bright.

Ch. E. 545. Petroleum Refinery Engineering.

3 or 3 or 3

Prerequisite: Ch. E. 412.

An introduction to the petroleum industry including (1) nature of petroleum and its fractions, octane numbers, viscosity relationships, etc. (2) operations of thermal and catalytic cracking, stabilization, alkylation, isomerization, crude fractionation, etc. (3) problem work covering high pressure phase relationships, and related material.

Mr. Pike.

- Ch. E. 546. Chemical Reaction Rates. 3 or 3 or 3
 Prerequisites: Ch. E. 415 and Chem. 532.
 A basic study of the rates of homogeneous reactions, heterogeneous reactions, and catalysis. Mr. Hazelton.
- Ch. E. 552. Pulp and Paper Laboratory. 2 or 2 or 2
 Corequisite: Ch.E. 541 or Ch. E. 542.
 Laboratory work in the technology of pulp and paper. Experimental work includes digestion and treatment of pulp, handsheet preparation and testing, fiber analysis, and chemical and physical tests. Messrs. Hazelton, Seely.
- Ch. E. 571, 572, 573. Chemical Engineering Projects. 2-2-2
 Prerequisite: Permission of instructor.
 A laboratory study of some phase of chemical engineering or allied field. Staff.

Courses for Graduates Only

- *Ch. E. 611. Heat Transfer I. 3-0-0
 Prerequisite: Ch. E. 313.
 An advanced course dealing primarily with heat transfer between liquids and solids, optimum operating conditions and design of equipment. Mr. Beatty.
- Ch. E. 612. Diffusional Operations. 0-3-0
 Prerequisite: Ch. E. 411.
 An advanced treatment of mass transfer particularly as applied to absorption, extraction, drying, humidification and dehumidification. (Offered in 1953-54 and alternate years.) Mr. Schoenborn.
- Ch. E. 613. Distillation. 0-3-0
 Prerequisite: Ch. E. 411.
 Vapor-liquid equilibria of non-ideal solutions, continuous distillation of binary and multicomponent systems, batch distillation, azeotropic and extractive distillation. (Offered in 1953-54 and alternate years.) Mr. Schoenborn.
- Ch. E. 614. Drying of Solids. 0-0-3
 Prerequisite: Ch. E. 411.
 An advanced course on the mechanism of drying operations with application to design of equipment, such as, cabinet, tunnel, rotary, drum and spray driers. Mr. Pike.
- Ch. E. 615, 616. Thermodynamics I and II. 3-3-0
 Prerequisite: Ch. E. 415 or equivalent.
 Advanced topics in chemical engineering thermodynamics including equilibria of physical and chemical systems, high pressure systems, generalized properties of hydrocarbons, etc. Mr. Beatty.
- Ch. E. 617. Catalysis of Industrial Reactions. 3 or 3 or 3
 Prerequisite: Ch. E. 546.
 A study of the mechanism of catalysis with emphasis on practical application to operation and design of industrial processes. Mr. Pike.

*Offered in 1952-53 and alternate years.

- Ch. E. 621. Heat Transfer II.** 0-0-3
 Prerequisite: Permission of instructor.
 Conduction, heating and cooling of solids, radiant heat transmission.
 (Offered in 1953-54 and alternate years.) Mr. Beatty.
- Ch. E. 631, 632, 633. Chemical Process Design.** 3-3-3
 Prerequisite: Ch. E. 411.
 Design and selection of process equipment, through solution of comprehensive problems involving unit operations, kinetics, thermodynamics, strength of materials and chemistry. Mr. Pike.
- Ch. E. 641, 642, 643. Advanced Chemical Engineering Laboratory.** 2-2-2
 Prerequisite: Permission of instructor.
 Advanced laboratory work in a selected field with emphasis on theory, techniques and performance of equipment. Mr. Pike.
- Ch. E. 651, 652, 653. Advanced Topics in Chemical Engineering.** 2-2-2
 Prerequisite: Graduate standing.
 A study of recent developments in chemical engineering theory and practice, such as ion exchange, crystallization, mixing, molecular distillation, hydrogenation, fluorination, etc. Staff.
- Ch. E. 656, 657, 658. Special Investigations in Chemical Engineering.** 3-3-3
 Prerequisite: Graduate standing.
 An intensive study of a special field through classroom study, literature surveys, plant visits, conferences and limited laboratory work. Staff.
- Ch. E. 661, 662, 663. Chemical Engineering Seminar.** 1-1-1
 Prerequisite: Graduate standing.
 Literature investigations and reports of special topics in chemical engineering and allied fields. Staff.
- Ch. E. 680. Chemical Engineering Research.** 3 to 9
 Prerequisite: Graduate standing.
 From 3 to 9 credit hours may be taken any term.
 Independent investigation of an advanced chemical engineering problem. A report of such an investigation is required as a graduate thesis. Staff.

DEPARTMENT OF CHEMISTRY

Graduate Faculty

Professors: WALTER JOHN PETERSON, Head, WREAL LESTER LOTT, WILLIS ALTON REID, GEORGE HOWARD SATTERFIELD, PAUL PORTER SUTTON, JOSEPH ARTHUR WEYBREW.

Associate Professors: CHARLES WARREN JENNINGS, RICHARD HENRY LOEPERT, COWIN COOK ROBINSON.

Assistant Professors: ROBERT RAYMOND HENTZ, CHARLES S. NEVIN, SAMUEL B. TOVE, RAYMOND CYRUS WHITE.

The Department of Agricultural and Biological Chemistry offers the Degree of Master of Science in Agricultural and Biological Chemistry. Before the master's degree is awarded, a student must have met the requirements

set forth by the Committee on Professional Training of the American Chemical Society for the baccalaureate degree, either at the institution in which he received his undergraduate training or at this institution. (Briefly the minimum course requirements in Chemistry for the bachelor's degree consist of four basic year courses in general chemistry, analytical chemistry, physical chemistry, and organic chemistry, together with at least one advanced course. Mathematics, comprising the equivalent of two years of college work, which must include one year of differential and integral calculus, is also required).

Instruction in Agricultural and Biological Chemistry trains students in this area of chemistry, strongly supported with fundamental training in the major divisions of chemistry and their applications. Educational, commercial, and research positions are open to men and women trained in the chemistry of plants, animals, soils, fertilizers, insecticides, foods and feeds, vitamins and nutrition, and clinical and biophysical chemistry. In the past the majority of graduates with the degree of Master of Science have continued their education toward the degree of Doctor of Philosophy with a major in one of the branches of chemistry.

The Department of Agricultural and Biological Chemistry is adequately equipped with standard instruments and apparatus available for both teaching and research. A sizable assortment of specialized equipment is also available such as: refractometers, incubators, forced air ovens, several spectrophotometers and photoelectric colorimeters, fluorophotometers, polarographs, etc. The spectrographic laboratory is one of the most complete to be found anywhere and is currently providing analyses for 10 elements on each of 25 plant samples per week.

An up-to-date shop equipped with standard power tools (drill press, lathes, band saws, etc.) is available to research workers for construction of special apparatus. Complete glass-blowing facilities are also available.

Complete sets of reference works and of more than one hundred chemical (including biochemical and nutritional) journals in English, German and French are accessible for student use in the D. H. Hill Library. Current numbers of the most widely used chemical journals (including all of those published by the American Chemical Society) are available in the Chemistry Library.

Research:

Some of the areas of specialization for research studies available include (1) the isolation, chemical nature, and nutritional significance of certain growth factors required by bacteria and yeasts; (2) soils and weather factors influencing the composition of plants; (3) vitamin and/or mineral studies of plants grown in the South, influence of variety, fertilization, etc.; (4) vitamin methodology; (5) nutritional requirements of various farm animals (in cooperation with the Nutrition Section, Animal Industry Department); (6) mechanisms involved in plant physiological processes; (7) techniques of spectrographic analysis and their applications in research with plants, soils, and animals; (8) preparation and characterization of fat acid esters and derived products; (9) others.

Courses for Advanced Undergraduates

- Chem. 419. Micro and Trace Chemistry.** 0-4-0
 Prerequisite: Chem. 213.
 Micro-chemistry deals with the techniques of chemical reactions, and the procedures in analysis, when the total samples available are extremely small. Trace chemistry deals with the methods of analysis and techniques in handling, when extremely small amounts of the chemical of interest is intermixed with relatively large amounts of other chemicals or elements. Applications deal with elements resulting from Nuclear Fission. Mr. Hentz.
- Chem. 421, 422, 423. Organic Chemistry.** 5-5-5
 Prerequisite: Chem. 212.
 Aliphatic and aromatic compounds; method of preparation and purification of compounds, emphasis on structure and mechanism of organic reactions. Mr. Reid.
- Chem. 425, 426. Organic Chemistry.** 4-4-0
 Prerequisite: Chem. 103.
 Required of students in Chemical Engineering.
 Lectures and laboratory exercises dealing with preparation, properties, structure, and applications of aliphatic and aromatic substances. Mr. Loeppert.
- Chem. 430. Organic Preparations.** 0-3-0
 Prerequisite: Three years Chemistry including Organic Chemistry.
 Experiments selected to acquaint the student with advanced methods and techniques in the preparation of organic substances. Mr. Loeppert.
- Chem. 451, 452. Introductory Biochemistry.** 4-4-0
 Prerequisite: Chem. 203.
 The fundamental biochemistry of living matter; lectures, laboratory. Mr. Satterfield.

Courses for Graduates and Advanced Undergraduates

- Chem. 527. Advanced Survey of Organic Chemistry.** 3-0-0
 Prerequisite: Three years Chemistry including Organic Chemistry.
 Underlying principles, interpretation of mechanisms, limitations in the use of organic reactions. Mr. Reid.
- Chem. 528. Organic Qualitative Analysis.** 0-3-0
 Prerequisite: Three years Chemistry including Organic Chemistry.
 A study of class reactions, functional groups, separation, identification and preparation of derivatives. Mr. Reid.
- Chem. 529. Organic Quantitative Analysis.** 0-0-3
 Prerequisite: Three years Chemistry including Organic Chemistry.
 Quantitative determination of carbon, hydrogen, nitrogen, the halogens, and sulfur in organic substances; selected procedures for quantitative determination of functional groups in organic materials. Mr. Loeppert.
- Chem. 531, 532, 533. Physical Chemistry.** 4-4-4
 Prerequisites: Chem. 213 or 217; Phys. 203, Math. 303.
 An intensive study of the states of matter, solutions, colloids, homogenous and heterogenous equilibria, reaction kinetics, electrolysis, conductance, oxidation reactions, ionic equilibria. Three lectures and one laboratory per week. Two terms are required of students in Chemical Engineering, three of those majoring in Chemistry. Messrs. Sutton, Jennings.
- Chem. 537. Instrumental Methods of Analysis.** 0-0-5
 Prerequisite: Three years Chemistry including Chem. 532.
 Lectures and laboratory exercises on physical methods of chemical analysis, the instruments employed, and the theoretical basis for their operation. Mr. Lott.

- Chem. 542. Colloid Chemistry.** 0-3-0
 Prerequisite: Three years Chemistry.
 Adsorption, preparation, purification, properties, constitution, stability and application of sols, gels, emulsions, foams, aerosols. Mr. White.
- Chem. 543. Chemical Technology in Radioactivity.** 0-0-3
 Prerequisites: Chem. 103, Phys. 507, 511, 515, and 520.
 Lecture discussion and laboratory practice of the general technology in manipulation of radioactive chemicals on a laboratory scale. Remote control apparatus for performing behind small shields the usual operations of precipitation, filtering, evaporation, mixing, liquid transfer, etc. Particular attention will be given to preparation of thin samples for counting, by evaporation, electroplating, etc. Mr. Hentz.
- Chem. 551. 552. General Biological Chemistry.** 4-4-0
 Prerequisite: Three years Chemistry, including Chem. 423.
 The chemical constitution of living matter. Biochemical processes as well as compounds are studied; lectures, laboratory. Messrs. Peterson, Nevin.
- Chem. 553. Physiological Chemistry.** 0-0-4
 Prerequisite: Chem. 552.
 Digestion, absorption, metabolism, secretions, and excretions. Laboratory will include analysis of blood and urine. Mr. Satterfield.
- Chem. 555. Plant Chemistry.** 0-0-4
 Prerequisite: Chem. 552.
 Composition of plants; properties, nature and classification of plant constituents; changes occurring during growth, ripening, and storage of plants or plant products. Mr. Weybrew.
- Chem. 561 (see A.I. 561). Chemistry of Proteins.** 0-3-0
 Prerequisite: Three years Chemistry including Chem. 423.
 Composition, distribution, structure, properties, amino acids, biological value. Mr. Peterson.
- Chem. 562. (see A.I. 562). Lipide Chemistry.** 3-0-0
 Prerequisite: Chem. 552 or equivalent.
 Classification, composition, distribution, biosyntheses, and metabolism of lipides. Analysis, syntheses, deterioration, physical properties and chemical reactions of fats and fatty acids. Messrs. Nevin, Smith.
- Chem. 563. Chemistry of Carbohydrates.** 0-0-3
 Prerequisite: Three years Chemistry including Chem. 423.
 History, classification, structures and reactions of carbohydrates and related materials. Mr. Robinson.
- Chem. 572. Chemistry of Vitamins.** 0-3-0
 Prerequisite: Three years Chemistry including Chem. 423.
 History, nomenclature, properties, distribution, effects of deficiencies, vitamin values. Mr. Satterfield.

Courses for Graduates Only

- Chem. 602. Advanced Organic Chemistry.** 0-3-0
Prerequisites: Chem: 527, 533.
Theoretical aspects of organic chemistry; relations between chemical constitution and physical properties. Mr. Loeppert.
- Chem. 603. Advanced Organic Chemistry.** 0-0-3
Prerequisite: Chem. 602.
Alicyclic and heterocyclic compounds, macromolecules, standard type reactions. Messrs. Reid, Loeppert, Robinson.
- Chem. 621 (see A.I. 621). Enzymes.** 4-0-0
Prerequisite: Chem. 552 and permission of instructor.
The kinetics, measurements, and nature of enzyme action; specific enzymes, coenzyme-enzyme-substrate systems and intermediary metabolism. Mr. Tove.
- Chem. 623 (see A.I. 623). Biological Assay of Vitamins.** 0-0-4
Prerequisites: Chem. 552, Stat. 512.
Techniques and designs of biological assays of vitamins; validity tests and methods for computing potency and confidence limits are emphasized. Mr. Sherwood.
- Chem. 631. Chemical Research.** Credits by arrangement
Prerequisite: 54 term credits in Chemistry. Open to all graduates.
Special problems that will furnish material for a thesis.
A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs. Staff.
- Chem. 641. Seminar.** Credits by arrangement
Required of graduate students specializing in Chemistry.
Preparation and presentation of abstracts of current publications in the field of Chemistry.
A maximum of three credits is allowed toward the Master's degree, but any number toward the Doctorate. Staff.
- Chem. 652, 653. Biochemistry.** 0-3-3
Prerequisite: Chem. 553 or 555.
Special topics in Biochemistry. Messrs. Satterfield, Peterson, Nevin.
- Chem. 671, 672, 673. Advanced Physical Chemistry.** 3-3-3
Prerequisite: Three years Chemistry including Chem. 532.
A continuation of Chem. 531, etc. along lines of kinetic theory, elements of statistical mechanics, and advanced thermodynamics. (Offered in 1953-54 and in alternate years.) Mr. Sutton.

DEPARTMENT OF CIVIL ENGINEERING

Graduate Faculty

Professors: RALPH EIGIL FADUM, Head, WILLIAM FARRINGTON BABCOCK, CHARLES RAYMOND BRAMER.
Associate Professors: CHARLES SMALLWOOD, JR., MEHMET ENSAR UYANIK.
Assistant Professors: CHARLES RUSSELL McCULLOUGH, NELSON LEONARD NEMEROW.

The Department of Civil Engineering offers graduate work leading to the Master of Science degree in the four following fields: sanitary engineering, soil mechanics and foundation engineering, structural engineering and transportation.

Laboratory facilities for sanitary engineering research work include an hydraulics laboratory, a chemical laboratory and a biological laboratory.

For work in soil mechanics and foundation engineering, a well-equipped laboratory with modern soil-testing equipment is available.

Facilities for structural engineering research include a modern and well-equipped physical testing laboratory and in addition an air-conditioned structural models laboratory.

Transportation engineering facilities include a bituminous laboratory, an airphoto interpretation laboratory, a photogrammetry laboratory, and a traffic engineering laboratory provided with modern traffic control devices.

In addition to these facilities, equipment for research is made available by the Department of Engineering Research.

Some unique opportunities for research are offered the graduate student in civil engineering by reason of the location of North Carolina State College in the State's capital city. There are a number of cooperative research endeavors with municipal and state governmental agencies that enable the student to gain valuable experience through an application of his knowledge and skill to actual engineering problems.

Courses for Advanced Undergraduates

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|---|-------|
| C. E. 421. Elements of Structural Design. | 3-0-0 |
| Prerequisite: E. M. 422. | |
| Required of seniors in Civil Engineering. | |
| The design of tension, compression and simple flexural members of steel, timber, and concrete. | |
| Messrs. Bramer, Uyanik. | |
| C. E. 422. Reinforced Concrete. | 0-3-0 |
| Prerequisite: C. E. 421. | |
| Co-requisite: C. E. 432. | |
| Required of seniors in Civil Engineering. | |
| Analysis and design of reinforced concrete building elements. | |
| Messrs. Bramer, Uyanik. | |
| C. E. 423. Structural Design. | 0-0-6 |
| Prerequisite: C. E. 422. | |
| Required of seniors in Civil Engineering. | |
| Specifications: connection details; independent and complete designs of engineering structures. | |
| Messrs. Bramer, Uyanik. | |
| C. E. 431. Analysis of Simple Structures. | 3-0-0 |
| Prerequisite: E. M. 312. | |
| Required of seniors in Civil Engineering. | |
| Stress analysis of statically determinate beams and framed structures, under fixed loads, influence line treatment for moving loads. | |
| Messrs. Bramer, Uyanik. | |
| C. E. 432. Indeterminate Structures. | 0-3-0 |
| Prerequisite: E. M. 422; C. E. 431. | |
| Required of seniors in Civil Engineering. | |
| Deflection of beams and trusses, indeterminate stress analysis by moment area, moment distribution and slope deflection. | |
| Messrs. Bramer, Uyanik. | |
| C. E. 441. Soil Mechanics. | 3-0-0 |
| Prerequisite: C. E. 342. | |
| Required of seniors in Civil Engineering. | |
| Fundamental stress relations, Mohr's rupture hypothesis, shearing strength, earth pressure theories, bearing capacity, stability of slopes, hydrostatics and hydrodynamics of ground water. | |
| Messrs. Fadum, McCullough. | |

C. E. 453. Contracts and Specifications.

0-0-3

Prerequisite: C. E. 332.

Required of seniors in Construction; technical elective.

Legal aspects of contract documents and specifications for engineering construction; duties and responsibilities of engineers and contractors on construction work; ethics and codes of practice; registration. Staff.

C. E. 484. Hydraulics.

0-3-0

Prerequisite: E. M. 430.

Required of seniors in Civil Engineering.

Uniform and non-uniform flow of water in open channels and pressure conduits; theory of design and characteristics of the various types of pumps and hydraulic motors, and flow measuring devices. Mr. Smallwood.

C. E. 486. Hydrology and Drainage.

0-3-0

Co-requisite: C. E. 484.

Required of seniors in Civil Engineering.

The occurrence, distribution and use of surface and ground waters; precipitation, runoff, storage, stream flow records, design of storm drainage and sewerage systems. Statistical analysis of related problems. Mr. Smallwood.

C. E. 489. Water Works.

0-0-3

Prerequisite: E. M. 430.

Required of seniors in Civil Engineering.

Methods of protecting water supplies; estimating water consumption; water supply and distribution systems; fundamentals of water treatment. Mr. Smallwood.

C. E. 491. Professional Practice.

1-0-0

Required of seniors in Civil Engineering.

Professional engineering societies and their functions; professional standards; topics of current interest to the Civil Engineer. Staff and Visiting Lecturers.

Courses for Graduates and Advanced Undergraduates

C. E. 501. Airphoto Interpretation.

3-0-0

Technical elective.

The technique of interpreting engineering data from aerial photographs.

A photographic study of soil and drainage conditions as they relate to site selection, location of granular materials, etc. Mr. McCullough.

C. E. 502, 503. Advanced Airphoto Analysis.

0-3-3

Prerequisite: C. E. 501.

Application of the techniques of airphoto interpretation to engineering projects, including engineering soil and drainage maps, location of borrow materials, preliminary reconnaissance for dam location and airport site selection. Student may schedule either or both terms. Mr. McCullough.

C. E. 504. Applied Photogrammetry.

0-3-0

Technical elective.

The construction of planimetric and topographical maps from terrestrial and aerial photographs. The use of stereoscopes, contour finders, sketch-masters, and radial line extension with field control. Mr. Babcock.

C. E. 505, 506. Airport Planning and Design.

3-3-0

Elements of site selection and airport layout; the detailed design and preparation of plans for an airport. Messrs. Babcock, McCullough.

- C. E. 511. Traffic Engineering. 3-0-0
Prerequisite: C. E. 303.
Technical elective.
Traffic studies and surveys as they pertain to the solution of basic traffic and highway problems. Fundamental geometric highway design.
Mr. Babcock.
- C. E. 525, 526, 527. Advanced Structural Design. 3-3-3
Prerequisite: C. E. 432.
Complete structural designs of conventional structures and of unusual projects. Principles of limit design.
Mr. Uyanik.
- C. E. 529. Analysis and Design of Masonry Structures. 0-0-3
Prerequisite: C. E. 432.
Technical elective.
Analysis and design of culverts, dams, foundations, retaining walls.
Messrs. Bramer, Uyanik.
- C. E. 535. Experimental Stress Analysis. 3-0-0
Prerequisite: C. E. 432.
Principles and methods of mechanical analysis; model analysis; applications of resistance strain gages on models and full-scale structures.
Mr. Bramer.
- C. E. 536, 537. Structural Laboratory. 0-3-3
Prerequisite: C. E. 535.
Test procedures, limitations and methods of interpretation. Experimental projects.
Mr. Bramer.
- C. E. 541. Fundamentals of Soil Mechanics. 3-0-0
Physical and mechanical properties of soils governing their use as engineering materials, stress relations and applications to a variety of fundamental problems.
Mr. Fadum.
- C. E. 542, 543. Soil Testing for Engineering Purposes. 0-3-3
Prerequisite: C. E. 441 or C. E. 541.
Qualitative and quantitative soil testing procedures for engineering purposes.
Mr. Fadum.
- C. E. 545. Foundation Engineering. 0-0-3
Prerequisite: C. E. 441.
Technical elective.
Subsoil investigations; excavations; design of sheeting and bracing systems; control of water; footings, and grillage and pile foundations; caisson and cofferdam methods of construction; legal aspects of foundation engineering.
Mr. Fadum.
- C. E. 584. Sanitary Microbiology. 0-0-3
Prerequisite: Bot. 412.
Mechanism and dynamics of disinfection and bacteriostasis. Microbiology of water and sewage and of sewage treatment processes. Mr. Nemerow.
- C. E. 585. Theory of Water and Sewage Treatment. 3-0 or 3
Study of the physical and chemical principles underlying water and sewage treatment processes; i.e., diffusion of gases into liquids, laws of solubility, equilibrium and ionization constants, anaerobic and aerobic stabilization, sludge conditioning and disposal.
Mr. Smallwood.

- C. E. 586. Analysis of Water and Sewage.** 0-3-0
Prerequisite: C. E. 585.
Laboratory experiments in water and sewage analysis. Microscopic examination of water. Interpretation of results and their significance.
Mr. Nemerow.
- C. E. 587. Unit Operations and Processes in Sanitary Engineering.** 0-0-3
Prerequisites: E. M. 430, C. E. 586.
A laboratory course in which processes and operations used in sanitary engineering practice are studied: sedimentation, aeration, filtration, adsorption, coagulation, softening, sludge digestion, and activated sludge.
Messrs. Smallwood, Nemerow.
- C. E. 589. Fundamentals of Sewage Works.** 3-0 or 3
Co-requisite: E. M. 430.
A survey of the fundamentals of sewage disposal and of sewage treatment.
Mr. Nemerow.
- C. E. 594, 595, 596. Civil Engineering Seminar.** 1-1-1
Discussions and reports of subjects in civil engineering and allied fields.
Graduate Staff.
- C. E. 599. Civil Engineering Projects.** 3 to 9
Special projects in some phase of civil engineering. Graduate Staff.

Courses for Graduates Only

(All graduate courses selected by the student are subject to approval by the student's adviser and the instructor in charge of the course.)

- C. E. 607. Pavement Design.** 3-0 or 3
Prerequisites: C. E. 303; E. M. 422.
Analysis of current practices in the design of flexible and rigid pavements for highways and airports.
Mr. Babcock.
- C. E. 613. Highway Engineering Economics.** 0-0-3
Prerequisite: C. E. 303.
Analysis of methods used for highway financing, sources of highway funds, highway taxation, and the cost of motor vehicle transportation.
Mr. Babcock.
- C. E. 614. Advanced Traffic Engineering.** 0-3-0
Prerequisite: C. E. 511.
The analysis and correlation of traffic survey data for the elimination of traffic congestion, the reduction of traffic hazards and accidents, the design of urban streets, and traffic signals.
Mr. Babcock.
- C. E. 616, 617. Geometric Highway Design.** 0-3-3
Prerequisite: C. E. 511.
The geometric highway design of intersections at grade, rotary type intersections; grade separation, multibridge, braided and direct connection design.
Mr. Babcock.
- C. E. 619. Design of Transportation Terminal Facilities.** 3-0 or 3
City and regional planning as it pertains to the design and location of transportation terminal facilities.
Mr. Babcock.



Laboratory Tests in Stream Pollution Research.

- C. E. 631, 632. Rigid Frame Analysis.** 3-3-0
 Prerequisite: C. E. 432.
 Analysis of simple, complex and multi-story rigid frames; Vierendell trusses; continuous bents and trusses. Messrs. Bramer, Uyanik.
- C. E. 633. Bridge Analysis.** 0-0-3
 Prerequisite: C. E. 432.
 Continuous trusses, treatment of redundant members, secondary stresses. Messrs. Bramer, Uyanik.
- C. E. 634. Theory and Design of Arches, Thin Shells and Domes.** 0-0-3
 Prerequisite: C. E. 631; Co-requisite E. M. 602.
 Analysis and design of hinged and rigid arches of both frame and rib construction; thin shells and domes. Messrs. Bramer, Uyanik.
- C. E. 638. Structural Connections.** 0-3-0
 Prerequisite: C. E. 631.
 Analytical study of stresses in standard connections; load capacities, rigidity of connections; modification of rigid frame analyses to treat frames with semi-rigid connections. Messrs. Bramer, Uyanik.
- C. E. 639. Structural Specifications.** 0-0-3
 Prerequisites: C. E. 631, 632.
 Evolution of bridge and building codes and specifications. Critical examination of loadings, working stresses and special code requirements; apparent inconsistencies among various specifications. Mr. Bramer.
- C. E. 644. Ground Water and Seepage.** 0-0-3
 Prerequisite: C. E. 441 or C. E. 541.
 Principles of hydraulics applied to ground water, theory of flow through idealized masses, the flow net solution, seepage and well problems. Mr. Fadum.
- C. E. 645, 646. Advanced Soil Mechanics.** 3-3-0
 Prerequisite: C. E. 441 or
 Co-requisite: C. E. 541.
 General principles involved in the theories of soil mechanics, conditions for shear failure, mechanical interaction between solids and water in soils and elasticity problems of soil mechanics. Mr. Fadum.
- C. E. 681. Advanced Water Supply.** 3-0-0
 Prerequisite: C. E. 489.
 Consideration and solution of complex problems which arise in the design of water supplies; evaluation of water resources of areas, required sizes for storage and distribution reservoirs, collection of ground waters, design of aqueducts and large transmission lines, design of municipal distribution systems. Mr. Smallwood.
- C. E. 682. Advanced Water Purification.** 0-3-0
 Prerequisite: C. E. 585.
 The detailed design of water purification units: sedimentation basins, mixing tanks, flocculation basins, filtration beds, chemical feed systems for coagulating and disinfecting agents. Messrs. Smallwood, Nemerow.

- C. E. 683. Advanced Sewerage.** 3-0-0
 Co-requisite: C. E. 589.
 Consideration and solution of complex problems in the design of sanitary sewer systems, storm sewer systems, and combined sewer systems; interceptor design and sea outfall designs. Mr. Smallwood.
- C. E. 684. Advanced Sewage Treatment.** 0-3-0
 Prerequisite: C. E. 683.
 Design of grit chambers, screens, sedimentation basins, Imhoff tanks, trickling filters, activated sludge plants, sludge digestion tanks. Consideration of requirements of incinerators, sludge gas utilization, sludge disposal beds. Disposal of municipal refuse and garbage. Mr. Nemerow.
- C. E. 685. Industrial Water Supply and Waste Disposal.** 0-0-3
 Prerequisite: C. E. 684.
 Study of the special requirements of industrial water supplies; i.e., waters for boilers, for paper industries, for food industries, and other selected industries. Study of industrial processes and the wastes they produce, along with methods of treatment and disposal: textile, pulp and paper, food, milk, canneries, etc. Mr. Nemerow.
- C. E. 689. Stream Sanitation.** 0-0-3
 Prerequisite: C. E. 684.
 A study of the biological, chemical and hydrological factors that affect stream sanitation and stream use. Mr. Nemerow.
- C. E. 690. Civil Engineering Research.** 3 to 9
 Independent investigation of an advanced civil engineering problem. A report of such an investigation is required as a graduate thesis. Graduate Staff.

DAIRY MANUFACTURING

Dairy Manufacturing is organized as a unit of the Department of Animal Industry. For a list of the faculty and a description of the resources of the Department, consult the section of the catalog under Animal Industry.

Courses for Advanced Undergraduates

- D.M. 401. Market Milk.** 3-0-0
 Market milk and related products from the standpoint of production, processing, distribution and public health inspection. Mr. Roberts.
- D.M. 402. Ice Cream Making and Merchandising.** 0-5-0
 Prerequisite: D.M. 401.
 Selection and preparation of ingredients, processing and freezing of ice cream and other frozen desserts. Also, modern methods of merchandising ice cream in the retail store and at the soda fountain. Mr. Warren.
- D.M. 403. Cheese Making.** 0-0-3
 Prerequisite: D.M. 401.
 Principles and practices in the manufacture, ripening, and marketing of the various types of cheese. Mr. Warren.
- D.M. 411. Dairy Bacteriology I.** 4-0-0
 Prerequisite: Bot. 412.
 Importance of microorganisms in milk and dairy products. Determination of numbers and types of bacteria in dairy products and their relationship to quality. Mr. Speck.

D.M. 423. Butter Making and Dairy By-products.

0-0-3

Prerequisite: D.M. 401.

Principles and practices in the manufacture of butter, condensed milk and other dairy by-products. Mr. Blanton.

Courses for Advanced Undergraduates and Graduates

D. M. 502. Dairy Chemistry.

0-3-0

Prerequisite: D. M. 401.

A qualitative study of the physical, colloidal, and chemical properties of milk and its constituents. Mr. Aurand.

D.M. 503. Dairy Plant Management.

0-0-4

Prerequisite: Approval of Instructor.

Business and factory management practices as used in the dairy plant.

Mr. Roberts.

D.M. 512. Dairy Bacteriology II.

0-3-0

Prerequisite: D. M. 411.

Methods for the recognition of bacteria important in milk and milk products, stimulation (associative growth, chemicals, etc.), and inhibition (bacteriophage, antibiotics, chemicals) of bacteria in milk. Mr. Speck.

D.M. 513. Advanced Dairy Technology.

0-0-4

Prerequisites: D.M. 401 and D.M. 411.

The functions and operations of a dairy control laboratory. A comprehensive study of methods of analysis for dairy products and related non-dairy products; the applications and interpretations of such methods for quality and composition control of dairy products. Mr. Warren.

Courses for Graduates Only

D.M. 601. Topical Problems in Dairy Manufacturing.

1-3 per term

Prerequisite: Graduate standing in Dairy Manufacturing.

A maximum of nine hours is allowed.

Staff.

D.M. 603. Advanced Dairy Bacteriology.

0-0-4

Prerequisite: Approval of instructor.

Microbiological fermentations involved in the utilization of milk by-products. Laboratory experiments deal with factors affecting fermentations, chemical and biological measurements of fermentation products.

Mr. Speck.

D.M. 611. Seminar in Dairy Manufacturing.

1 credit per term

Prerequisite: Graduate standing in Dairy Manufacturing.

Scientific articles, progress reports in research, and special problems of interest are reviewed and discussed.

A maximum of three credits is allowed toward the Master's degree, but any number toward the Doctorate. Staff.

D.M. 613. Advanced Dairy Chemistry.

0-0-4

Prerequisite: Approval of instructor.

A quantitative study of the physical, colloidal, and chemical properties of milk and its constituents. Mr. Aurand.

D.M. 621. Research in Dairy Manufacturing. Credits by arrangement

Prerequisite: Graduate standing in Dairy Manufacturing.

A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs. Staff.

DEPARTMENT OF DIESEL AND INTERNAL COMBUSTION ENGINES

Graduate Faculty

Professors: ROBERT BARTON RICE, Head, ADOLF HOERMANN.

The Graduate Department of Diesel and Internal Combustion Engines established by the trustees of the University of North Carolina, was created to carry on research activities and graduate studies in the Diesel field and associated branches of technology.

The educational plan of the department is designed around the industry's need for scientists, designers, and research workers, not only in the manufacture of Diesels but in the numerous fields of transportation and power generation where they are universally employed. The prime function of the department is to offer education at the graduate level for both graduate degrees and for the retraining of engineers now in industry. The educational program is integrated closely with research projects involving both pure science and applied science.

The department now offers programs of study leading to the degree of Master of Science in Diesel Engineering built around exacting requirements in the fields of Diesel design, Diesel power plant design, experimental Diesel engineering, and Diesel operation and maintenance.

The research requirements for graduate degrees will be met in the department's new and modern laboratories, which are equipped to investigate all phases of the Diesel, away from the confining and demanding requirements of manufacturing and production in an environment dominated by scientifically trained minds, where the study and development of Diesels is *sine qua non*. Here studies and investigations will be conducted by imaginative and creative thinking young men.

The program of study is designed to be liberal to a point where a candidate may in addition to his Diesel studies select graduate courses in the fields of chemistry, economics, electrical engineering, engineering mechanics, mathematics, modern languages, mechanical engineering, physics, or statistics. Any student with a satisfactory scholastic record and a Bachelor's Degree, or the equivalent, from an accredited and recognized college or university will be admitted. A Diesel graduate student will be subject to all regulations and conditions of the Graduate School of the University of North Carolina.

It is the plan of the department to cooperate closely with the Diesel manufacturers as well as those fields wherein the Diesel is the most economical and universal prime-mover, especially the field of Transportation. Toward this end the department maintains close contact with the Diesel Industry and the Professional Societies dedicated to promote the Science of Oil and Gas Power.

The department encourages summer employment in the Diesel industry for its graduate students in an effort to vitalize the student's program of study and to better integrate it with the actual scientific problems of this industry.

A student enrolled as an upperclassman in an accredited college or university and planning to continue his studies at the graduate level in the Diesel field will find it advantageous to consult with this department concerning the selection of his curriculum and senior electives.

Courses for Advanced Undergraduates

Dies. 405. Internal Combustion Engines.

3 or 3 or 3

Prerequisite: M.E. 307.

The principles of thermodynamics, mechanics, and kinematics as applied to the design, construction, and operation of the internal combustion engine.

Mr. Cochran.

Courses for Graduates and Advanced Undergraduates

Dies. 507, 508, 509. Internal Combustion Engine Fundamentals.

3-3-3

Prerequisite: M.E. 309.

The fundamentals common to internal combustion engine cycles of operation. The Otto engine: carburetion, fuel distribution, flame propagation, normal and knocking combustion, throttling, pumping, valve and spark timing, and altitude effects; the Diesel engine: injection and spray formation, fuel rating, atomization, penetration, diesel knock, combustion, pre-combustion, and scavenging, as applied to reciprocating and rotary engines.

Staff.

Dies. 511, 512, 513. Internal Combustion Engine Fuels.

2-2-2

Prerequisite: M.E. 309.

A development of the formation, composition, processing, and treatment of gaseous, liquid, solid, and colloidal fuels, their preparation, combustion, ignition temperatures, inflammability, products of combustion, specifications, CRC tests, and impurity determinations, as they would influence the design, operation, and maintenance of the internal combustion engine. The potentialities of new sources of energy are explored.

Mr. Lineberry.

Dies. 521, 522, 523. Engine Balancing.

2-2-2

Co-requisite: Dies. 507, 508, 509.

The mathematical and analytical analysis, and determination of first, second and fourth order forces, couples and torques, influencing bearing pressures and stresses resulting from the reciprocating and rotating masses for single-cylinder, multi-cylinder, in-line, radial, and vee-engines, and the determining and locating of weights for static and dynamic balancing of crankshafts, camshafts, and accessories. Symmetry, cylinder arrangement, and firing orders are studied.

Mr. Hoermann.

Dies. 531. Survey of Internal Combustion Engines.

3-0-0

Co-requisite: Dies. 507.

A survey of contemporary American and European internal combustion engines, with emphasis on Diesel engine designs, from the standpoint of dimensions, performance characteristics, and operation as influenced by design details.

Staff.

Dies. 532, 533. Engine Design.

0-3-3

Prerequisite: Dies. 531.

Diesel engine parts, sub-assemblies, components, and their bearings and supports are studied from the aspect of strength, stress distribution, materials, method of manufacture, finishes, and treatment. Frames, bases, moving parts, components, and accessories are designed around standards adopted by the industry. Welding, casting, and forging practices of the industry are studied.

Mr. Hoermann.

Dies. 536. Aircraft Engines.

0-3-0

Prerequisite: M.E. 309.

Spark-ignition, compression-ignition, and jet engines are studied from the standpoint of design, construction, and operation and as they apply to aircraft.

Mr. Hanse.

Dies. 562, 563. Diesel Engine Applications.

0-3-3

Prerequisite: Dies. 531.

Co-requisite: Dies. 508, 509.

A study of the application of the Diesel engine in the fields of transportation, portable power plants, and stationary power plants. Case histories and methods for the selection of Diesel engines to satisfy the power requirements of each field are investigated.

Mr. Rice.

Dies. 581, 582, 583. Internal Combustion Engine Experimentation.

2-2-2

Co-requisite: Dies. 507, 508, 509.

The testing of fuels, lubricants, induction systems, and exhaust systems; smoke determination, instantaneous measurements of combustion pressure, temperature, chemical composition, turbulence, and distribution; performance testing and calibration of fuel pumps and injectors; DEMA tests, and simulated altitude tests.

Mr. Hanse.

Dies. 585, 586, 587. Internal Combustion Engine Laboratory.

2-2-2

Co-requisite: Dies 507.

Laboratory exercises in the fields of spark-ignition and compression-ignition heat engines.

Mr. Cochran.

Courses for Graduates Only

Dies. 601, 602, 603. Internal Combustion Engine Calculations.

3-3-3

Prerequisite: Dies. 509, Math. 401.

An advanced study of the conversion of chemical energy in spark-ignition and compression-ignition engines as influenced by Gibbs phase rule, Gibbs-Dalton law, fugacity of gas mixtures, in the analysis of conventional engine cycles, compound power cycles, closed cycles, and Kreislauf cycle, in the determination of efficiencies and performance as functions of power output and ambient conditions. Kadenacy and inertia charging effects on two-cycle engines are analyzed.

Mr. Rice.

Dies. 621, 622, 623. Internal Combustion Engine Vibration Analysis.

3-3-3

Co-requisite: Dies. 507, 508, 509.

Prerequisite: Math. 401.

Equivalent elastic systems and configurations for internal combustion engines and their rotating and reciprocating masses, elasticities of crankshafts, drive shafts, and couplings, methods of calculating natural frequencies, elastic modes, exciting torques, and stresses, energy absorbing and dynamic dampers, vibration isolators, vibrations in engine parts, turbine blades, valve springs, intake and exhaust manifolds, injection pipes, and parallel operation are studied mathematically and graphically.

Mr. Hoermann.

Dies. 661, 662, 663. Internal Combustion Engine Power Plant Design. 3-3-3

Prerequisite: Dies. 531.

The power requirements for typical industrial, municipal, institutional and regional power plants are analyzed, survey reports and specifications compiled, design and detail layouts executed, and installation schedules developed with the internal combustion engine as the source of power.

Mr. Rice.

Dies. 671, 672, 673. Internal Combustion Engine Auxiliaries. 3-3-3

Prerequisite: Dies. 531.

Advanced study, mathematical analysis and design calculations of: vane, displacement, and centrifugal blowers, superchargers and pressure chargers, mechanically and turbine driven; fuel pumps, metering devices, injectors and injection systems; engine governors, torque and speed control mechanisms.

Staff.

Dies. 691, 692, 693. Seminar. 1-1-1

A convocation of faculty and students engaged in advanced study.

Staff.

Dies. 695. Internal Combustion Engine Research. Credits by arrangement

Research in the internal combustion engine field.

Staff.

DEPARTMENT OF ECONOMICS

No graduate degrees are offered in Economics at North Carolina State College. Graduate programs leading to advanced degrees in this field are offered at the University of North Carolina at Chapel Hill. The courses listed below are eligible for graduate credit when they form a part of an approved graduate program in other departments.

Courses for Advanced Undergraduates

Econ. 401, 402, 403. Principles of Accounting. 3-3-3

Required of sophomores in Forestry; Wood Tech., Lumber Prod. Mdse., juniors in Ag. Econ., Ind. E., Tex. (alternate with Psych.), Furn. Mfg.-Mgt. Econ. 401, 402 required of sophomores Heat. and Air Cond., juniors in Const.

Fundamental principles of theory and practice; interpretation of the structure, form, and use of business statements.

Messrs. Shulenberger, Fails.

Econ. 407. Business Law. 3 or 3 or 3

Prerequisite: Junior standing.

Required of juniors in Forestry; Lumber Prod. Mdse., Heating and Air Cond., Ind. Arts Educ., Ind. Engr.; Furn. Mfg., and Mgt., seniors in Land. Arch., Forestry; Wood Tech., Arch. 5th year.

Sources of law; fields of law; contracts, agency sales; negotiable documents; the law as it controls business transactions.

Messrs. Lyons, Manning.

Econ. 408. Advanced Business Law. 0-0-3

Prerequisite: Econ. 407.

A continuation of Economics 407, including bailments, suretyship, real property; corporations; recent developments in State and Federal Law.

Mr. Lyons.

Econ. 409. Construction Accounting. 0-0-3

Prerequisites: Econ. 401, 402.

Required of juniors in construction.

An introduction to the accounting problems peculiar to a construction organization. An analysis of the problems of estimating and allocating the costs of materials, labor and overhead to individual jobs.

- Econ. 410. Manufacturing Accounting.** 0-0-3
 Prerequisites: Econ. 401, 402.
 Required of juniors in Industrial Engineering.
 An introduction to the accounting problems peculiar to a manufacturing organization. An analysis of the problems of estimating and allocating the costs of materials, labor and overhead to the various units of product.
- Econ. 411, 412, 413. Marketing Methods and Sales Management.** 3-3-3
 Prerequisites: Econ. 301, 302, 303; Econ. 344, 345, 346.
 Required of seniors in Tex. Mgt.; juniors in Forestry, Lumber Prod. Mdse.; Econ. 411, 412 required of juniors in Farm Mkt., and Farm Fin.; Seniors in Furn. Mfg. and Mgt.
 Marketing functions, agencies, systems; retailing; marketing analysis; problems in marketing; elements of sales management. Mr. Moen.
- Econ. 415. Advertising.** 0-0-3
 Prerequisites: Econ. 301, 302, 303.
 Principles of advertising. Mr. Moen.
- Econ. 418. Money and Credit.** 3-0-0
 Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.
 The functions, history, and development of money and credit; contemporary policies and relation to prices; interrelations of money and credit in banks and financial institutions. Mr. Moen.
- Econ. 419. Modern Banking.** 0-3-0
 Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.
 Origin and development of banking in the United States; functions and operations of the modern bank; banking laws; Federal Reserve System. Mr. Moen.
- Econ. 420. Corporation Finance.** 0-0-3
 Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.
 Raising and spending of funds and standards of control. Mr. Moen.
- Econ. 425, 426. Industrial Management.** 3-3-0
 Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.
 Required of juniors in Textiles and Textile Chemistry and Dyeing, elective for all others.
 Required of seniors in Ind. and Rural Recreation.
 Principles and techniques of modern scientific management; relationship of finance, marketing, industrial relations, accounting, and statistics to production; techniques regarding specific problems; analysis of economic, political, and social influences on production. Messrs. Wood, Bartley.
- Econ. 431. Labor Problems.** 3-0-0
 Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.
 Required of seniors in Constr. and Ind. Engr.
 An economic approach to labor problems, including such topics as insecurity, wages, hours, working conditions, substandard workers, legislation aimed at correcting existing evils. Mr. Wood.
- Econ. 432. Industrial Relations.** 0-3-0
 Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.
 Required of seniors, Constr., Ind. Engr., Ind. E. Furn. Opt., Ind. Engr. Furn. Mfg. and Mgt.
 Collective bargaining. Analysis of basic labor law and its interpretation by courts and government agencies. Examination of specific terms of labor contracts and their implications for labor and management. Examination of labor objectives and tactics and management objectives and tactics. Mr. Wood.
- Econ. 433. Personnel Management.** 3 or 3 or 3
 Prerequisites: Econ. 301, 302, or Econ. 344, 345, 346.
 Required of juniors in Textiles and Textile Chemistry and Dyeing, seniors in Ind. Engr., Ind. E. Furn. Opt., Ind. Engr. Furn. Mfg. and Mgt., Heat. and Air Cond.
 Emphasis on the human problems of industry. A review of the scientific techniques and results of research regarding the problems of employment; training, promotion, transfer; health and safety; service and welfare; and Joint relations. Messrs. Wood, Bartley.

Econ. 435. Time Study.

0-3-0

Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.

Analysis of shop operation into elements, and the determination of the time for each element; emphasis on factors affecting job specification, and wage-rate setting.

Mr. Wood.

3 or 3-0

Econ. 468. Survey of Statistical Methods.

Prerequisites: Econ. 301, 302, 303.

Methods of describing quantitative data; collection and methods of analysis of statistical materials; charts and graphs for presenting numerical facts.

Staff.

Econ. 469. Statistical Technique.

0-3-0

Prerequisite: Econ. 468.

The problem of estimation, correlation; simple linear and nonlinear forms; normal curve and probable error; methods of sampling.

Staff.

Courses for Graduates and Advanced Undergraduates

Econ. 501. Advanced Economic Theory.

3-3-0

Prerequisite: Eighteen (18) term credits in Economics.

Recent and current economic theory; principal schools of economists; theory of prices under the system of free enterprise.

Staff.

Econ. 502. History of Economic Doctrines.

0-0-3

Prerequisite: Econ. 501.

History of economic doctrines from the Mercantilists to the recent Economists.

Staff.

Econ. 503. Advanced Accounting.

3-0-0

Prerequisites: Econ. 401, 402, 403 and Econ. 301, 302.

Problems of asset valuation, such as depreciation, replacements, amortization, etc., found in all types of business organizations.

Mr. Shulenberger.

Econ. 504, 505. Principles of Cost Accounting.

0-3-3

Prerequisites: Econ. 401, 402, 403 and Econ. 301, 302.

Required of seniors in Textile Management.

Cost finding, material costs, labor costs, overhead costs, etc.

Mr. Shulenberger.

Econ. 510. Public Finance and Taxation.

0-3-0

Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.

Classes of income and expenditure; incidence of different classes of taxes.

Mr. Moen.

Econ. 514. International Economic Relations.

0-0-3

Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.

Backgrounds and some newer developments in international economics, with special emphasis on the position of the United States in world trade.

Staff.

Econ. 515. Investment Problems and Policies.

0-3-0

Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.

Different types of investments and methods of judging them. Managing personal finances.

Mr. Moen.

Econ. 518. Principles of Insurance.

0-0-3

Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.

Elective.

Risk as an element of all agricultural and industrial activity; discussion of such risks as can be covered by insurance with the appropriate form of insurance, e.g., employer's liability, workmen's compensation, fire, life, and other forms.

Mr. Shulenberger.

Econ. 509. Introduction to Linear Programming. 0-0-3

Prerequisite: Econ. 302 or Econ. 345; Math. 303 or Math. 313; and consent of instructor.

An introduction to recent developments in the organization of interdependent activities. The exposition of elementary portions of the mathematical theory will be followed by discussion of applications in economics, agriculture, and industry. Mr. Harrell.

Econ. 521. Office Management. 3 or 3 or 3

Prerequisites: Open to seniors and graduate students only.

The application of scientific management principles to office problems including: office planning and layout, equipment appliances, filing, correspondence supervision, selection and training of office employers, promotions and wage increases, office costs and budgets. Mr. Wood.

Econ. 531, 532, 533. Management of Industrial Relations. 3-3-3

Prerequisites: Open to seniors and graduate students only.

A seminar course:

An examination of the entire field of industrial relations. Economic, social, labor and management's points of view. The relation to and effects of industrial relations on management problems and policies. Mr. Wood.

Econ. 541, 542, 543. Economics of Transportation. 3-3-3

Prerequisites: Econ. 301, 302, 303 or Econ. 344, 345, 346.

The economic aspects of transportation facilities provided by the railroads, highways, and air- and water-transportation agencies; principles and problems of rate making, operation, management, valuation, coordination and government regulation. Staff.

SCHOOL OF EDUCATION

Graduate Faculty

Professors: JAMES BRYANT KIRKLAND, Dean, ROY NELS ANDERSON, KEY LEE BARKLEY, THOMAS I. HINES, IVAN HOSTETLER, DANNIE JOSEPH MOFFIE, CLARENCE CAYCE SCARBOROUGH.

Associate Professors: LOUIS BALANTINE BERES,* HAROLD MAXWELL CORTER, FELIX ALEXANDER NYLUND,* MARSHALL LANGDON SCHMITT.

Assistant Professors: PAUL JAMES RUST, ELIAS LAKE TOLBERT.

The School of Education offers graduate programs leading to the Master's degree in Agricultural Education, Industrial Arts Education, Industrial Education, Occupational Information and Guidance, and Industrial Psychology. Graduate students in education may pursue programs leading to the Master of Science degree or to the Master's degree in a professional field. Both degrees are recognized by the State Department of Education.

The Master of Science Degree

The Master of Science degree is regarded as a research degree and as preparation for further graduate study. Programs leading to the Master of Science degree are planned to include a major (30 credit hours) in some specialized area of education and a minor (15 or more credit hours) in some other field such as psychology or agronomy. If two minors are chosen, a minimum of 9 credits will be required in each.

* On leave 1953-54.

A reading knowledge of one modern foreign language is required.

A thesis representing an original investigation in the major field must be prepared.

The Master's Degree in a Professional Field.

The professional degree is designed to meet the needs of students who are preparing themselves for teaching in the secondary schools. The program of study meeting the requirements for this degree differs from that expected for the Master of Science in that a wider latitude is permitted in the choice of course work outside the major.

A problem may be substituted for a thesis if, in the opinion of the student's advisory committee, this alternative best meets the requirements of the student's program.

A knowledge of a foreign language is not required to meet the requirements for the professional degree.

A total of at least forty-five credit hours is required, at least twelve hours of which must be in course work at the 600 level. Not more than three courses will be accepted at the 400 level and all of these must fall outside of the major field.

The School of Education is located in Tompkins Hall where well equipped laboratories and research facilities are provided for graduate study.

The Department of Industrial Arts has a well equipped laboratory for students to secure practical experience and to carry out experimental and research programs. The laboratory has been rated as one of the best in the Southeast. In addition, the Department utilizes the industrial arts facilities of the public schools for research work.

The Department of Psychology operates a Psychological Clinic which provides individual testing and counseling service to students. The Department also operates a Bureau which is equipped to conduct personnel evaluations, employee counseling, personnel training, aptitude testing, attitude surveys, personnel research and other psychological services. A Division of Occupational Vision Research has been established in the Department of Psychology to incorporate all research in vision. The emphasis of the vision studies is directed toward occupational efficiency and safety.

The Department of Occupational Information and Guidance utilizes the facilities of the public schools, Public Employment Bureau, business and industrial establishments, Welfare agencies, and the Psychological Clinic as laboratories whereby students can secure practical experience while working for their Master's degrees.

The Department of Agricultural Education utilizes the resources of the School of Agriculture and the Experiment Station. In addition, the School has a well equipped farm shop laboratory.

Holders of advanced degrees in education are much in demand to fill responsible positions in the secondary school system of the State. Teachers with advanced degrees qualify for Graduate Teacher's Certificates which automatically place them in higher salary brackets.

GENERAL COURSES

Courses for Graduates and Advanced Undergraduates

Ed. 501. Education of Exceptional Children. 3-0-0

Advanced Undergraduates or Graduates. Prerequisite: six hours in education or psychology.

Discussion of principles and techniques of teaching the exceptional child with major emphasis on the mentally handicapped and slow learner. Practice will be given in curriculum construction for groups of children, individual techniques for dealing with retarded children in the average classroom. Opportunity for individual work with an exceptional child will be provided.

Mr. Corter.

Ed. 502. Analysis of Reading Abilities. 3-0-0

Prerequisites: six hours in education or psychology.

A study of tests and techniques in determining specific abilities; a study of reading retardation and factors underlying reading difficulties. Mr. Rust.

Ed. 503. Improvement of Reading Abilities I. 0-3-0

Prerequisites: six hours in education or psychology.

A study of methods used in developing specific reading skills or in overcoming certain reading difficulties; a study of the problem of providing for individual differences in reading ability and an appreciation of the need for differentiated instruction in the classroom.

Mr. Rust.

Ed. 504. Improvement of Reading Abilities II. 0-0-3

Prerequisites: six hours in education or psychology.

A study of methods used in developing pupil vocabularies and word analysis skills; a study of how to control vocabulary burden of reading material.

Mr. Rust.

Ed. 552. Industrial Arts in the Elementary School. 3 or 3 or 3

Prerequisites: 12 credits in education and consent of instructor.

This course is organized to help industrial arts majors and elementary teachers and principals to gain an understanding of the materials, processes and products of industry; to show how these may be used to vitalize the elementary school program.

Graduate Staff.

Ed. 615. Introduction to Educational Research. 3 or 3 or 3

An introductory course for those students preparing for an advanced degree. It is designed to develop an understanding of the meaning and development of research and research needs in the field of education. It includes a study of the basic methods and procedures commonly used in selecting problems, and in collecting, analyzing, and interpreting data.

Staff.

AGRICULTURAL EDUCATION

Courses for Advanced Undergraduates

Ed. 407. Methods of Teaching Vocational Agriculture. 3 or 3

A study of the techniques, the selection of reference materials, supplies, apparatus and equipment needed for teaching vocational agriculture; promoting F.F.A. programs; guiding students in selecting and conducting farming programs; organizing programs for out-of-school groups.

Messrs. Armstrong, Jones.

Ed. 411. Student Teaching in Agriculture. 15 or 15 or 15

Prerequisites: Ed. 313, 407.

Students will spend one quarter observing, planning and teaching vocational agriculture in all-day, young farmer and adult farmer classes. This course also provides instruction and

of vocational agriculture. During the summer, prior to the year in which students register for student teaching, they shall spend two weeks in a department of vocational agriculture. It is recommended that one week be spent in the selected high school community before the school term begins and the other week immediately following the opening of the school term. This course will be conducted under the supervision of the members of the Department of Agricultural Education and the supervising teachers in the selected centers. Staff.

Ed. 430. Senior Seminar.

0-1 or 1

Prerequisites: Senior standing in agricultural education, permission to register.

Problems in directed teaching developing from experience in student teaching.

Mr. Scarborough.

Courses for Graduates and Advanced Undergraduates

Ed. 554. Planning Local Programs of Vocational Agriculture. 3 or 3 or 3

Consideration of the community as a unit for planning programs in agricultural education; objectives and evaluation of community programs; use of advisory groups; school and community relationships organization of the department and use of facilities; the role of the FFA. Designed for teachers in service, particularly beginning teachers.

Messrs. Scarborough, James.

Ed. 558. Special Problems in Teaching Agriculture.

A maximum of 9 credits may be acquired in this course.

Current problems in agricultural education. Opportunities for students to study particular problems under the guidance of the staff.

Graduate Staff.

Ed. 561. Trends in Teaching Vocational Agriculture.

3 or 3 or 3

Designed to develop an understanding of the significant trends in agricultural education, particularly as to their impact on the job of teaching vocational agriculture. (Not offered in 1953-54.)

Ed. 562. Course Building in Vocational Agriculture.

3 or 3 or 3

Determining objectives, student participation, interpretation and use of source materials, selection and organization of subject matter, time, coordination of class work, farm mechanics and FFA. Major emphasis given to high school courses but consideration also given to out-of-school classes.

Mr. Scarborough.

Ed. 563. Guidance and Individual Instruction.

3 or 3 or 3

Prerequisites: 18 credits in Education, including 6 in Agricultural Education.

Individualized instruction applied to vocational agriculture; agricultural occupations, guidance, and counseling with special reference to pupils in vocational agriculture. Designed for teachers in service. (Not offered in 1953-54.)

Ed. 565. Supervised Farming Programs.

3 or 3 or 3

Planning of comprehensive programs of supervised farming, their relation to the instructional program, supervision, and evaluation. Designed for teachers of vocational agriculture.

Mr. Kirkland.

Ed. 568. Adult Education in Agriculture.

3 or 3 or 3

This course is designed to meet the needs of teachers as leaders in adult education. More emphasis is being given to working with adults as part of the community program of vocational agriculture. This course will give

the teacher an opportunity to study some of the basic problems and values in working with adult groups. Particular attention will be given to the problem of fitting the educational program for adults into the high school program of vocational agriculture. Messrs. Scarborough, Coggin.

Courses for Graduates Only

Ed. 616. Problems in Agricultural Teaching. 3 or 3 or 3

Prerequisites: At least 18 credits in Education and permission to register.

Problem solving technique, review of studies in agricultural education, completing research problems. Messrs. Kirkland, Scarborough.

Ed. 617. Philosophy of Agricultural Education. 3 or 3 or 3

Prerequisites: Eighteen credits in Education and permission to register.

Principles and practices involved in the leadership of a teacher of agriculture and in making his work effective in a rural community. Study of leaders in the field. Messrs. Kirkland, Scarborough.

Ed. 618. Agricultural Education Seminar. A maximum of 3 credits.

Prerequisite: Eighteen credits in Education.

A critical review of current articles and books of interest to students of agricultural education. Graduate Staff.

Ed. 621. Research in Agricultural Education. A maximum of 9 credits.

Prerequisite: Eighteen hours in Education and permission to register.

One or more research problems under the guidance of a member of the staff. Graduate Staff.

Ed. 664. Supervision in Agricultural Education. 3 or 3 or 3

Organization, administration, evaluation and possible improvement of present supervisory practice; theory, principles and techniques of effective supervision in agricultural education at different levels.

Messrs. Kirkland, Scarborough.

INDUSTRIAL ARTS AND INDUSTRIAL EDUCATION

Courses for Advanced Undergraduates

I. A. 420. Tools and Materials. 3 or 3 or 3

A study of the development, care and maintenance of hand and machine tools; and of the sources, manufacture, characteristics, uses, and costs of industrial materials and products.

Mr. Schmitt.

Ed. 422. Methods of Teaching Industrial Subjects.

0-3-0

Prerequisites: Ed. 344, Psychol. 304.

A study of the principles and methods of teaching manipulative skills and related technology; organization of subject matter, lesson planning and student appraisal. Staff.

Ed. 433. Field Work in Secondary Education.

0-3-0

Prerequisites: Ed. 344 and permission of instructor.

A study of pupil-teacher-community relationships at the secondary school level involving observations, visits, reports, readings and conferences. Staff.

Ed. 440. Vocational Education.

3 or 3 or 3

Prerequisites: Ed. 344, Psychol. 304.

A comprehensive study of the types of vocational education of less than college grade, provided for through Federal legislation; an evaluation of the effectiveness of the program; and a detailed study of the North Carolina Plan. Staff.

Ed. 444. Student Teaching in Industrial Subjects.

15 or 15 or 15

Prerequisites: Ed. 422, 433.

Observation of and active participation in full time off-campus student teaching in the public schools for a full term under supervision. Staff.

I. A. 460. The General Shop.

0-3-0

Prerequisite: Senior standing or permission of instructor.

The student is given actual participation in the organization, management, teaching problems, selection, planning and construction of projects on a general shop or laboratory of industries basis. Mr. Hostetler.

Courses for Graduates and Advanced Undergraduates

Ed. 516. Community Occupational Surveys.

0-3-0

Prerequisites: Six credits in Education and consent of instructor.

Methods in organizing and conducting local surveys and evaluation of findings in planning a program of vocational education. Graduate Staff.

Ed. 521. Organization of Related Study Materials.

3 credits

Prerequisite: Ed. 422 or consent of instructor.

The principles of selecting and organizing both technical and general related instructional material for trade extension and diversified occupations classes. Graduate Staff.

Ed. 525. Trade Analysis and Course Construction.

3 or 3 or 3

Prerequisites: Ed. 344, Psychol. 304.

Principles and practices in analyzing occupations for the purpose of determining teaching content. Practice in the principles underlying industrial course organization based on occupational analysis covering instruction in skills and technology and including course outlines, job sequences, the development of industrial materials and instructional schedules.

Graduate Staff.

Ed. 527. Philosophy of Industrial Education.

0-3-0

Prerequisites: Ed. 344, Psychol. 304.

A presentation of the historical development of industrial education; the philosophy of vocational education; study of Federal and State legislation pertaining to vocational education; types of programs, trends and problems.

Graduate Staff.

Ed. 528. Principles and Practices in Diversified Occupations.

3 credits

Prerequisite: Ed. 422 or consent of instructor.

A study of the development, the objectives, and principles of diversified occupations. The organization, promotion and management of programs in this area of vocational education.

Graduate Staff.

Ed. 552. Industrial Arts in the Elementary School.

3 or 3 or 3

(See description on page 78)

I. A. 570. Laboratory Problems in Industrial Arts. A maximum of 9 credits

Prerequisites: Senior standing and permission of instructor.

Courses based on individual problems and designed to give advanced majors in industrial arts education the opportunity to broaden or intensify their knowledge and abilities through investigation and research in the various fields of industrial arts, such as metals, plastics, or ceramics.

Graduate Staff.

- I. A. 575. Special Problems in Industrial Arts. A maximum of 9 credits
Prerequisite: One term of student teaching or equivalent.
The purpose of these courses is to broaden the subject matter experiences in the areas of industrial arts. Problems involving experimentation, investigation and research in one or more industrial arts areas will be required.
Graduate Staff.
- Ed. 580. Modern Industries. 3 or 3 or 3
Prerequisites: 12 credits in Education and consent of the instructor.
Elective course for advanced undergraduate and graduate students in industrial arts. Designed to assist teachers in guiding students to sources of information relative to various modern industries.
Mr. Hostetler.
- Ed. 582. Curriculum Problems in Industrial Arts. 3-0-0
Prerequisites: Psychol. 304 and 6 credits in Education.
Planning and organization of learning experiences in the industrial arts area.
Mr. Hostetler.
- Ed. 583. Instructional Aids and Devices. 0-3-0
Prerequisites: Psychol. 304 and 6 credits in Education.
Analysis of learning units, and the preparation of instructional aids and devices.
Mr. Hostetler.
- Ed. 584. School Shop Planning and Equipment Selection. 0-0-3
A course for advanced undergraduate and graduate students.
The physical planning of school shops and laboratories; selection of tools and equipment. Whenever possible, actual or contemplated school buildings will be used for class work.
Mr. Hostetler.
- Ed. 592. Individual Problems in Education. 3 or 3 or 3
An elective course for graduate students in Industrial Arts Education and Industrial Education, with consent of instructor.
Individual and group studies of one or more major problems in industrial arts and industrial education. Problems will be approached through the application of research techniques with final reports prepared in a form suitable for publication as a magazine article, technical or professional bulletin.
Mr. Hostetler.
- Ed. 595. Industrial Arts Workshop. 3 credits
A course for experienced teachers, administrators and supervisors of industrial arts. The primary purpose will be to develop sound principles and practices for initiating, conducting and evaluating programs in this field. Enrollees will pool their knowledge and practical experiences and will do intensive research work on individual and group problems.
(Offered in Summer School only.)
Mr. Hostetler.

Courses for Graduates Only

- Ed. 610. Administration and Supervision of Vocational Education. 3 or 3 or 3
Prerequisites: Psychol. 304, Ed. 344, 440, 520, or equivalent.
Administrative and supervisory problems of vocational education; practices and policies of Federal and State offices; organization and administration of city and consolidated systems.
Graduate Staff.



Experimentation with New Clay in the Industrial Arts Department.

Ed. 614. Modern Principles and Practices in Secondary Education. 3 or 3 or 3
Required of graduate students in Guidance, Industrial Arts and Industrial Education.

Foundations of modern programs of secondary education; purposes, curriculum, organization, administration, and the place and importance of the high school in the community in relation to contemporary social force.

Graduate Staff.

Ed. 624. Research in Industrial Arts Education. A maximum of 9 credits
Prerequisites: 18 credits in Education and permission of instructor.

The student will be guided in the selection of one or more research problems and in the organization of the problems, methods of gathering data, procedure for analyzing data, and best practice for interpreting and reporting data.

Mr. Hostetler.

Ed. 627. Research in Industrial Education. A maximum of 9 credits
Prerequisites: 18 credits in Education and permission of instructor.

The student will be guided in the selection of one or more research problems and in the organization of the problems, methods of gathering data, procedure for analyzing data, and best practice for interpreting and reporting data.

Graduate Staff.

Ed. 630. Philosophy of Industrial Arts. 3 or 3 or 3
Required of all graduate students in Industrial Arts Education.

Current and historical developments in industrial arts; philosophical concepts, functions, scope, criteria for the selection and evaluation of learning experiences, laboratory organization, student personnel programs, community relationships, teacher qualifications, and problems confronting the industrial arts profession.

Mr. Hostetler.

Ed. 635. Administration and Supervision of Industrial Arts. 3 or 3 or 3

A study of the problems and techniques of administration and supervision in the improvement of industrial arts in the public schools. Selection of teachers and their improvement in service and methods of evaluating industrial arts programs.

Mr. Hostetler.

OCCUPATIONAL INFORMATION AND GUIDANCE

Courses for Graduates and Advanced Undergraduates

Ed. 520. Principles of Guidance. 0-3 or 3

This course aims to help teachers, administrators, and other non-specialists to do better the guidance work for which they are responsible. The course will cover the principles and procedures of Guidance programs at the secondary school level. Consideration will be given to counseling with individuals regarding health, social, emotional, educational, and vocational problems.

Mr. Tolbert.

Ed. 524. Occupational Studies. 0-0-3

This course is intended to acquaint individuals with the field of occupational information. An analysis will be made of the various types of occupations and occupational trends in North Carolina and the country as a whole.

Mr. Tolbert.

Ed. 590. Individual Problems in Guidance.

0-3-0

Intended for individual or group studies of one or more of the major problems in Guidance and Personnel work. Problems will be selected to meet the interests of individuals. The workshop procedure will be used whereby special projects and reports will be developed by individuals and by groups.

Messrs. Anderson, Tolbert.

Courses for Graduates Only

Ed. 631. Educational and Vocational Guidance.

3-0-0

This course aims to provide training for teachers who are part time or full time counselors, employment interviewers, social workers and personnel workers, who are aiding individuals with vocational adjustment problems. The course will cover the functions performed in vocational and educational guidance such as assembling and imparting occupational information, counseling regarding vocational and educational plans, the use of aptitude tests, placement in jobs and follow-up, and procedures in setting up services of vocational and educational guidance in schools, employment offices, and social service agencies.

Mr. Anderson.

Ed. 632. Occupational Analysis.

0-3-0

This course is designed to aid counselors, employment workers, personnel managers, and research workers to study occupational trends and to make occupational studies. An analysis and an evaluation of the techniques and of the research will be made in the field of job analysis, job evaluation and job specifications. Implications for curriculum building, industrial personnel and vocational guidance are considered.

Mr. Anderson.

Ed. 633. Techniques in Guidance and Personnel.

0-0-3

The aim of this course is to develop personnel techniques for counselors, social workers, employment interviewers, and industrial personnel workers. The techniques to be studied intensively are observation, interviews, counseling, rating scales, records and reports, and case study procedures. Students become acquainted with these techniques through lectures, demonstrations, and the study of case histories. Attention will be given to both diagnosis and treatment.

Mr. Anderson.

Ed. 641. Field Work in Occupational Information and Guidance.

A maximum of 9 credits

A practical course in which the student undertakes field work in secondary schools, colleges, social service agencies, employment offices, and industrial establishments which carry on guidance and personnel work. The student may observe and participate in some personnel services and may study the organization and administration of Guidance Programs.

Mr. Anderson.

Ed. 651. Research in Occupational Information and Guidance.

A maximum of 9 credits

Qualified students will conduct investigations and research in Guidance and Personnel. Published reports and techniques of investigation will be analyzed and evaluated.

Messrs. Anderson, Tolbert.

PSYCHOLOGY

See Psychology

DEPARTMENT OF ELECTRICAL ENGINEERING

Graduate Faculty

Professors: CORNELIUS GODFREY BRENNECKE, Head, VICTOR STUART CARSON, WILHELM FRIEDERICH GAUSTER, GEORGE BURNHAM HOADLEY, WILLIAM DAMON STEVENSON, JR.

Associate Professor: ARTHUR RAYMOND ECKELS.

The graduate degrees offered by the Department of Electrical Engineering are the Master of Science in Electrical Engineering (M.S. in E.E.) and the Doctor of Philosophy in Electrical Engineering (Ph.D. in E.E.).

Graduate work in Electrical Engineering at the first-year or master's level divides naturally into two general fields: electronics and communication on the one hand, and electric power on the other. In the more advanced study required for the doctorate, however, this distinction tends to disappear.

At North Carolina State College, the graduate offering in electronics and communication includes courses in Electric Communication, Communication Networks, Advanced Radio Engineering, Radiation and Antennas, and Vacuum Tube Design. These courses are supplemented by experimental work carried on in various special departmental laboratories, such as the high-vacuum laboratory and the microwave laboratory. These special laboratories, together with a number of small laboratories in which graduate students carry on individual research problems, are in the newly constructed Daniels Hall addition.

Graduate students specializing in electric power have the opportunity of taking courses in Electric Transmission, Power Network Calculations, Theory and Design of Electric Machines, Industrial Electronics and Control, High Voltage Engineering, and Power Systems. In this case also there are special laboratories, such as the high-voltage laboratory and the servomechanisms laboratory, in which laboratory instruction related to these courses is given, and there are individual research rooms for thesis work. In several instances theses in this field have been based on experimental work done by graduate students on the equipment of the Carolina Power and Light Company system, and this type of mutually beneficial cooperation between the Department of Electrical Engineering and the industries of North Carolina is always encouraged.

Advanced courses of a more general and fundamental nature, such as Electric Transients, Electromagnetic Fields, Advanced Electrical Measurements, and Advanced Electromagnetic Theory, are recommended for all graduate students in Electrical Engineering, especially those who plan to carry their advanced studies to the level of the doctorate. Minor sequences of study in advanced mathematics or physics are planned to fit the needs of individual students.

A close cooperation exists between the Department of Electrical Engineering and the Department of Engineering Research. Sponsored projects of many sorts in the general field of electrical engineering are carried on, each under the direction of one of the graduate staff. These projects, as a

general rule, make use of the part-time services of one or more graduate students, who thus have the opportunity to earn a substantial portion of their expenses, to gain research experience and inspiration under expert leadership, and to base their master's theses or doctoral dissertations on research work of real importance.

Theses submitted by graduate students in electrical engineering during recent years cover a wide range of topics, and include successful studies on the development of new field-plotting devices, on new methods of measuring the speed of rotating machines, on new techniques of high-voltage measurement, on new methods for predicting the performance of antennas, on the comparative performance of various electric power distribution connections, and on the automatic analysis of graphically recorded data. A number of these theses have been published in technical journals of national circulation and others in the bulletins of the Department of Engineering Research.

Men who have earned their graduate degrees in electrical engineering at North Carolina State College are in continual demand. Alumni of the post-war period hold important positions in industrial, government, and university research laboratories, in the teaching profession, and in the administrative and engineering departments of manufacturing corporations and public utilities.

Courses for Advanced Undergraduates

- E. E. 401, 402. Alternating Current Machinery.** 3-3-0
 Prerequisite. E. E. 302, E. E. 305.
 Required of seniors in E. E.
 Principles and characteristics of single and polyphase transformers, induction motors, and synchronous machines. Messrs. Eckels, Fouraker.
- E. E. 411, 412, 413. Advanced Dynamo Laboratory.** 1-1-1
 Required of seniors in E. E. Concurrent with E. E. 401, 402.
 Experimental studies and tests on transformers, alternating current motors and generators, and transmission lines. Staff.
- E. E. 415a, 416a. Fundamentals of Electronics.** 0-3-3
 Prerequisites: For. E. E. 415a, E. E. 301, and Math. 303; for E. E. 416a, E. E. 302.
 Required of juniors in E. E.
 A study of the fundamentals of electrical conduction in vacua and gases. Operating characteristics of vacuum and gaseous tubes, mercury arc rectifiers, photoelectric cells, cathode-ray oscilloscopes, etc. Introduction to vacuum tube circuit theory.
 Messrs. Brennecke, Hoadley, Stevenson.
- E. E. 415b, 416b. Electronic Laboratory 1 and II.** 0-1-1
 Co-requisites: E. E. 415a, E. E. 416a.
 Required of juniors in E. E.
 A laboratory course designed to illustrate the principles studied in E. E. 415a and 416a. Staff.
- E. E. 424. Central Stations.** 0-0-3
 Prerequisites: M. E. 309, E. E. 402.
 Optional, for E. E. seniors, with E. E. 583.
 Layout and operation of steam and hydroelectric stations. Prime movers and auxiliary equipment; bus systems, switchgear, etc. Management, plant economics, rate making, federal regulations. Mr. Fouraker.
- E. E. 445, 446, 447. Electrical Engineering Pro-Seminar.** 1-1-1
 Prerequisite: Senior Standing.
 Required of seniors in E. E.
 Weekly meetings for the delivery and discussion of student papers on topics of current interest in Electrical Engineering. Mr. Brennecke.

Courses for Graduates and Advanced Undergraduates

- E. E. 501. Electric Transients.** 3-0-0
 Prerequisites: E. E. 302, Math. 401.
 Required of seniors in E. E.
 An introductory study of the transient behavior of electrical circuits; switching transients and pulsed linear networks. Operational methods of analysis are emphasized. Messrs. Brennecke, Gauster.
- E. E. 503. Electromagnetic Fields.** 0-0-3
 Prerequisites: E. E. 303, Math. 401.
 Required of seniors in E. E.
 A re-survey of the classical theory of electricity and magnetism and its application to the problems of electrical engineering. The viewpoint of vector analysis is used throughout. Static fields; potential and force fields; field calculations and plotting; Maxwell's Equations; introduction to guided waves and radiant fields. Messrs. Brennecke, Gauster.
- E. E. 510. High Voltage Laboratory.** 2 or 2 or 2
 Prerequisite: E. E. 303 or Physics 401.
 A laboratory course in the techniques of producing and handling high voltages. Corona, surface discharge, breakdown, and other transient phenomena are studied. Typical high voltage tests are performed on dielectrics. One lecture and one laboratory session each week. Mr. Gauster.
- E. E. 527. Electric Transmission.** 3-0-0
 Prerequisites: E. E. 303, Math. 303.
 Optional, for E. E. seniors, with E. E. 581.
 Long distance transmission of power. Determination of line constants by the method of geometric mean distances. The general circuit constants and equations. Regulation, loss, and efficiency prediction by circle diagrams. Mr. Stevenson.
- E. E. 528. Power Network Calculations.** 0-3-0
 Prerequisite: E. E. 527.
 Optional, for E. E. seniors, with E. E. 582.
 The method of symmetrical components applied to fault calculation in power system networks. Equivalent impedances of short and long lines with and without terminal grounding and for ground wires, transformer banks, synchronous machines, asynchronous machines. Syntheses of complete systems, with calculations of fault currents for different types of faults. Mr. Stevenson.
- E. E. 529. Electric Power Applications.** 0-0-3
 Prerequisite: E. E. 402.
 Design and selection of electrical equipment for various industrial applications: mine hoists, electric traction, steel mills, etc. Speed control. Mr. Stevenson.
- E. E. 571. Industrial Electronics and Control.** 3-0-0 or 0-0-3
 Prerequisites: E. E. 416a, 416b; Co-requisite: E. E. 401.
 A study, with laboratory tests, of the application of electronic devices to industrial processes and equipment outside the field of Communication. Speed and voltage control; timing devices; electronic heating; air purification; production and quality control; photoelectric devices. Mr. Glenn.

E. E. 573. Fundamentals of Servomechanisms. 3-0-0 or 0-0-3
 Prerequisites: Math. 401, E. E. 302 or 321.
 Dynamics and synthesis of closed-loop control systems using transient and sinusoidal analyses. Applications to practical electrical, mechanical, and chemical systems. Mr. Eckels.

E. E. 581, 582, 583. Electric Communication. 3-3-3
 Prerequisites: E. E. 303, 416a, 416b.
 Optional, for E.E. seniors, with E. E. 527, 528, and 424.
 A classroom and laboratory study of the circuits and equipment involved in radio and wire communication: amplifiers, oscillators, modulation and detection, etc. Mr. Carson.

Courses for Graduates Only

E. E. 605, 606, 607. Electrical Engineering Seminar. 1-1-1
 Prerequisite: Graduate standing in E. E.
 A series of papers and conferences participated in by the instructional staff, invited guests, and students who are candidates for advanced degrees. Mr. Hoadley.

E. E. 611, 612, 613. Communication Networks. 3-3-3
 Prerequisites: E. E. 303, E. E. 501.
 Steady state and transient performance of the generalized network. Analysis and synthesis of two- and four-terminal reactive networks. Wave filters and phase equalizers. Networks containing resistances and reactances. Corrective and broad-band networks. Mr. Hoadley.

E. E. 614. Feedback Systems. 0-0-3
 Prerequisite: E. E. 612. E. E. 613 is to be taken concurrently.
 A study of feedback systems, such as feedback amplifiers, regulators, and servomechanisms. The study includes both the analysis and the synthesis of such systems, in terms of transient and steady-state response, using mathematical methods based on the theory of the complex variable. Mr. Hoadley.

E. E. 615. Electromagnetic Waves. 3-0-0
 Prerequisite: E. E. 503.
 Maxwell's Equations applied to a study of the propagation of energy by electromagnetic waves. Vector and scalar potentials; retarded potentials; plane and spherical waves; reflection and refraction; power flow and energy density; dispersion, scattering, and diffraction; fields in wave guides and resonant cavities. Mr. Carson.

E. E. 616, 617. Advanced Radio Engineering. 0-4-4
 Prerequisites: E. E. 582, 615.
 Analysis and design of transmitting, receiving, and measuring systems at microwave frequencies. Transmission lines, wave guides, and cavity resonators as circuit elements. Electronic methods of pulsing and timing with applications to pulse-time communication, television, navigation, radar, and measuring systems. Very broad-band amplifiers. Associated laboratory practice illustrating techniques of measurement and design at ultra-high and microwave frequencies. Mr. Carson.

E. E. 618. Radiation and Antennas.

0-0-4

Prerequisite: E. E. 615.

Electromagnetic wave theory applied to antennas and antenna arrays. Calculation and measurement of field patterns. Directive and non-directive antennas of various sorts.

Mr. Carson.

E. E. 621. Physical Electronics.

3-0-0

Prerequisites: E. E. 416, 582; Math. 401.

Analysis of electron tube behavior and function in terms of electron action. Laws of electron motion, electronic and ionic conduction, electronic emission. Determination of potential fields. Electron optics. Basic tube types, including cathode-ray and photoelectric tubes.

Mr. Carson.

E. E. 622. Vacuum Tube Design.

0-3-0

Prerequisites: E. E. 503, 621.

A study of the dependence of vacuum tube performance on construction and internal fields. An introduction to experimental tube construction and high vacuum practice is included.

Mr. Carson.

E. E. 623. Transit Time Effects.

0-0-3

Prerequisites: E. E. 615, 621.

A study of vacuum tube operation as affected, at high frequencies, by the transit time of electrons across interelectrode space. Topics studied include noise in vacuum tubes, velocity-modulated tubes, magnetrons, and special tubes.

Mr. Carson.

E. E. 631, 632, 633. Theory and Design of Electrical Machines.

3-3-3

Prerequisite: E. E. 402.

An advanced study of electrical machine theory. Saturation of magnetic circuits, leakage fluxes, loss distribution, and temperature rise. Transient and sub-transient reactances of synchronous machines. Stability and hunting of electrical machinery. Equivalent circuits of induction and synchronous machines. Commutation. Applications to design problems.

Mr. Eckels.

E. E. 634. Transmission Line Transients.

0-0-4

Prerequisite: E. E. 501.

Guided traveling waves; their initiation, reflection, attenuation and distortion. Lightning and switching surges on lines. Protective devices.

Mr. Gauster.

E. E. 635. High Voltage Engineering.

3-0-0

Prerequisite: E. E. 527.

A study of the considerations entering the design of electrical equipment for use at high potentials. Insulators and insulation design. Corona loss and surface leakage. Methods of measurement and test at high potentials.

Mr. Gauster.

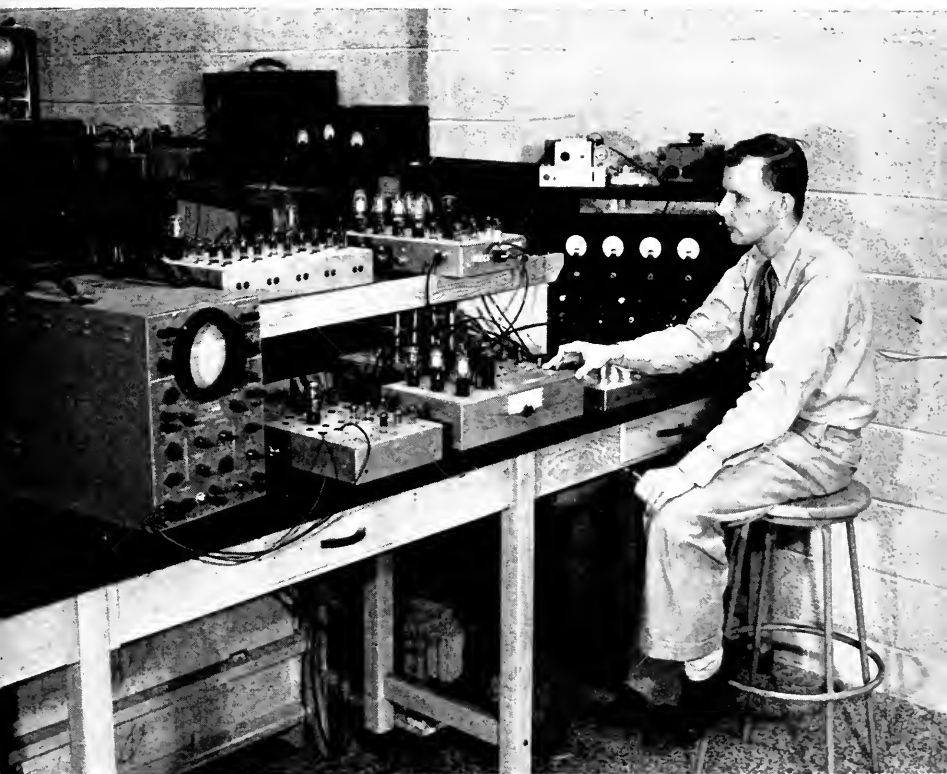
E. E. 636. Dielectrics and Insulating Materials.

0-3-0

Prerequisite: E. E. 402.

The behavior of electrical insulating materials as dielectrics. The theory of solids applied to dielectric conduction and breakdown. The electrical properties and uses of oils, silicates, plastics, ceramics, etc.

Mr. Gauster.



Research on a New Graphical and Numerical Photoelectronic Data-Analyzer.

E. E. 637, 638, 639. Power Systems.

3-3-3

Prerequisite: E. E. 528.

Network reduction, sequence impedances of lines and transformers, the calculation of fault currents and voltages by the method of symmetrical components. The study of machine reactances. The calculation of system stability with particular emphasis on the transient case. The application of circuit breakers and relays.

Mr. Stevenson.

E. E. 643. Advanced Electrical Measurements.

3-0-0

Prerequisites: E. E. 303, E. E. 416.

A critical analysis of circuits used in electrical measurements, with special attention to such topics as balance convergence, effects of strays, sensitivity, and use of feedback in electronic devices.

Mr. Hoadley.

E. E. 645, 646, 647. Advanced Electromagnetic Theory.

3-3-3

Prerequisite: E. E. 615 or Physics 602.

A comprehensive study of electricity and magnetism, emphasizing dynamic field theory. Potential theory, boundary-value problems, electrostatics and magnetostatics, conduction phenomena, wave propagation, electromagnetic theory of light.

Mr. Gauster.

E. E. 650. Electrical Engineering Research.

Credits by arrangement

Prerequisite: Graduate standing in E. E., and approval of adviser.

Individual research in the field of Electrical Engineering.

Graduate Advisers.

E. E. 661, 662, 663. Special Studies in Electrical Engineering.

3-3-3

Open only to candidates for the doctorate.

This course provides an opportunity for small groups of advanced graduate students to study, under the direction of qualified members of the professional staff, advanced topics in their special fields of interest.

Graduate Staff.

DEPARTMENT OF ENGINEERING MECHANICS

Graduate Faculty

Professors: GEORGE WALLACE SMITH, Head. ADOLPHUS MITCHELL.

The Department of Engineering Mechanics offers graduate work leading to the Master of Science degree in the fields of fluid mechanics, stress analysis, elasticity, and other areas in theoretical and applied mechanics. Students proficient in these subjects are in demand as investigators in machine or structural design, as teachers in engineering schools and as research members of large industrial companies.

Courses for Advanced Undergraduates

E. M. 422. Strength of Materials.

3-0 or 3

Prerequisite: E. M. 321.

Required of students in C. E., M. E.

A continuation of E. M. 321. Various methods for finding the slope and deflection of beams; determination of stresses in statically indeterminate beams; the study of columns, combined stresses; energy of strain.

Messrs. Smith, Mitchell, Hardee.

E. M. 430. Fluid Mechanics.

Prerequisite: E. M. 312.

Required of students in C. E., E. E., Geol. E., M. E.

A study of the fundamental principles of mechanics of fluids; properties of fluids; intensity of pressure; hydrostatic pressure on area; applications of hydrostatics; kinematics of fluid flow; dynamics of fluid flow; applications of hydrokinetics; friction losses in pipes; flow through pipes; dynamic forces.

Messrs. Long, Middleton.

3 or 3 or 3

Courses for Graduates and Advanced Undergraduates

E. M. 531. Hydraulic Machinery.

3 or 3-0

Prerequisite: E. M. 430.

Elective for Engineering seniors and graduate students.

The application of the principles of fluid mechanics to hydraulic pumping and power machinery; impulse and reaction type turbines; turbine laws and factors; pumping and machinery; centrifugal pumps, efficiency, capacity and selection of pumps.

Mr. Long.

E. M. 551. Advanced Strength of Materials.

3-0-0

Prerequisite: E. M. 422.

Elective for Engineering seniors and graduate students.

A course offered as a basis for advanced subjects in the several departments of the Engineering School. The subject matter covers the studies of stress at a point by the use of Mohr's Circle, springs, curved bars, shear flow, and deformations beyond the elastic limit. Messrs. Smith, Mitchell.

E. M. 554. Vibration Problems.

0-0-3

Prerequisites: E. M. 422, Math. 401a or 401b.

Elective for Engineering seniors and graduate students.

Free vibrations without damping; forced vibrations without damping; free vibrations with viscous damping; forced vibrations with damping; steady state forced vibrations with damping; vibration of systems with several degrees of freedom; vibration isolation and absorption; vibrating instruments; equivalent systems; balancing.

Messrs. Smith, Mitchell.

E. M. 556. Advanced Mechanics.

0-3-0

Prerequisite: E. M. 313.

Elective for Engineering seniors and graduate students.

Principle of virtual work; Coriolis' law of motion; gyroscopic action; balancing; variable acceleration; differential equations of motion; applications to engineering problems.

Messrs. Smith or Long.

Courses for Graduates Only

E. M. 601. Strain Energy Methods of Stress Analysis.

0-3-0

Prerequisite: E. M. 422.

The application of strain energy for the evaluation of deflections and statically indeterminate reactions resulting from axial, transverse, and torsional loads on beams, trusses, rigid frames, and curved members.

Messrs. Smith, Mitchell.

E. M. 602. Elastic Stability.

0-0-3

Prerequisites: E. M. 422, Math. 401a or 401b.

A practical study of beams supported by an elastic foundation, beam columns, and buckling problems. The application to design problems in calculating critical loads on columns, beam columns, curved members, trusses, plates, and shells.

Messrs. Smith and Mitchell.

- E. M. 603. Introduction to Elasticity. 0-0-3
Prerequisites: E. M. 601, Math. 412.
Mathematical analysis of internal stresses in circular and rectangular plates. Problems involving symmetrical deformations, and stress concentrations. Messrs. Smith, Mitchell.
- E. M. 605. Research in Strength of Materials. Credits by arrangement
Special problems and investigations. Graduate staff.
- E. M. 606. Research in Mechanical Vibrations. Credits by arrangement
Special problems and investigations. Graduate staff.
- E. M. 607. Research in Fluid Mechanics. Credits by arrangement
Special problems and investigations. Graduate staff.
- E. M. 608. Advanced Fluid Mechanics. 3-0-0
Prerequisite: E. M. 430.
A study of more advanced problems than taken up in E. M. 430; resistance of immersed and floating bodies, the boundary layer theory, separation, effects of viscosity, skin friction; dynamics of fluids; special problems in fluid mechanics. Mr. Long.
- E. M. 610. Engineering Mechanics Seminar. 1-1-1
Reports, discussions, and preparation of papers. Graduate staff.
- E. M. 611, 612. Similitude for Engineers. 3-3-0
Prerequisites: E. M. 321, E. M. 430.
The study of the use of models as aids in engineering design; principles and methods of dimensional analysis; design, construction and testing of models; interpretation of results; use of models of beams and shafts under static and dynamic loading; applications to problems of fluid flow; distorted models; application to advanced problems in mechanics of elastic solids; dissimilar models. Mr. Long.

ENTOMOLOGY

A UNIT OF THE DIVISION OF BIOLOGICAL SCIENCES

Graduate Faculty

Professors: CLYDE FUHRMAN SMITH, Head, BENTLEY BALL FULTON, ZENO PAYNE METCALF, THEODORE BERTIS MITCHELL, HENRY KEITH TOWNES, JR.*

Associate Professors: CHARLES H. BRETT, WALTER MICHAEL KULASH.

Assistant Professors: JAMES R. DOGGER, WILLIAM A. STEPHEN.

The Master of Science and Doctor of Philosophy degrees are offered in entomology. The work in entomology is well supported by strong departments in chemistry, statistics, and the plant and animal sciences. Excellent facilities for advanced study and research are provided in the new and modern building designed for the use of the biological sciences. Equipment includes modern greenhouses, air conditioned laboratories with precision temperature and humidity control, spray chambers, dust towers and low temperature rooms. Facilities are provided to support research in insect toxicology, physiology, biology and ecology.

*On leave 1952-54.

The collections of adult and immature insects plus the library facilities provide opportunities for unlimited work in insect taxonomy. Teaching personnel has been so selected that well-trained individuals are available to teach the specialized courses in the various phases of advanced entomological work.

Opportunities for employment of well-trained entomologists are plentiful and varied. Research and teaching opportunities exist in many state institutions. Federal agencies offer many positions in control, research, museum, and regulatory work. Private industry is using more and more entomologists in the development, production, control testing and sale of agricultural chemicals. Other opportunities in entomology as consultants in domestic or foreign service as well as in private business and sales are available. Or, one can go into business for himself as a pest control operator or as an insecticide formulator.

Courses for Graduates and Advanced Undergraduates

***Ent. 501, 502, 503. Insect Biology.** 3-3-3

Prerequisite: Ent. 302 or 311.

Life histories, reproduction, growth, metamorphosis, protection, food relations, hibernation, social relation, and adaptations. Given 1953-54.

Mr. Mitchell.

Ent. 511, 512, 513. Systematic Entomology. 3-3-3

Prerequisite: Ent. 302 or 311.

The classification, habits and development of insects. Includes techniques of collection, methods of mounting and preparation, and use of keys. The student is expected to develop a familiarity with the orders and principal families of insects and to develop the ability to recognize each major group.

Mr. Mitchell.

***Ent. 521, 522, 523. Insect Morphology.** 3-3-3

Prerequisite: Ent. 302 or Ent. 311.

External and internal morphology of insects. Given 1953-54.

Mr. Metcalf.

***Ent. 531, 532, 533. Insect Ecology and Behavior.** 3-3-3

Prerequisite: Ent. 302 or Ent. 311.

Environmental factors, biotic interrelations, orientations, instinctive activities, and distribution by communities. Given 1954-55.

Mr. Fulton.

***Ent. 542, 543. Immature Insects.** 0-3-3

Prerequisite: Ent. 511 or permission of instructor. Methods of collecting, preserving, and determining immature insects. 542 will deal primarily with the taxonomy of the orders with some work on the more important families. 543 will deal with classification to families with some work on genera and species. Given 1954-55.

Mr. Smith.

***Ent. 552. Entomological Technique.** 0-3-0

Prerequisite: Ent. 302 or Ent. 311.

Methods of collecting and preserving insects; rearing techniques; entomological drawing and other methods of illustrating; a study of insecticide equipment for laboratory and field research. Given in 1954-55.

Staff.

*Given in alternate years.

- *Ent. 561, 562, 653. Applied Entomology.** 3-3-3
Prerequisite: Ent. 302 or 311.
General principles of chemical, biological and cultural control of insects with special emphasis on contact insecticides, stomach poisons and fumigants. Given 1953-54. Mr. Fulton.
- *Ent. 571. Biological Control of Insects.** 3-0-0
Prerequisite: Ent. 513.
Insect parasites and predators, diseases of insects, methods of rearing and disseminating insects for biological control. Given 1954-55. Staff.
- Ent. 572. Insect Pests of Vegetable Crops.** 0-3-0
Prerequisite: Ent. 302.
A survey of the more important truck crop pests, their life histories and principles of control. Mr. Brett.
- *Ent. 573. Fruit Insects.** 0-0-3
Prerequisite: Ent. 302.
Detailed study of the pests of pome, stone and small fruits, their life histories and principles of control. Given 1953-54. Mr. Smith.
- Ent. 581. Insect Pests of Field and Forage Crops.** 3-0-0
Prerequisite: Ent. 302.
Detailed study of field and forage crop insects, their life histories and control. Mr. Kulash.
- Ent. 582. Forest Entomology.** 0-3-0
Prerequisite: Ent. 302 or 311.
Insects of forests and forest products with emphasis on the factors governing abundance and the application of this knowledge in control. Mr. Kulash.
- *Ent. 593. Medical Entomology. See Zool. 593.** 0-0-3
Prerequisite: Permission of the instructor.
A study of the morphology, biology, and control of the parasitic arthropods of man, domestic, and wild animals. Given 1953-54. Mr. Harkema.

Courses for Graduates Only

- *Ent. 601, 602, 603. Principles of Taxonomy.** 3-3-3
Prerequisite: Ent. 513.
Taxonomic literature, bibliographic methods, codes of nomenclature, zoogeography, taxonomic concepts, handling research material and constructing keys and descriptions. Given 1953-54. Staff.
- *Ent. 612. Insect Physiology.** 0-5-0
Prerequisite: Permission of instructor.
General principles of insect physiology with experimental studies on nutrition, digestion, excretion, circulation, respiration, and the nervous system of insects. Given 1953-54. Mr. Gast.

*Given in alternate years.

***Ent. 622. Insect Toxicology.**

0-5-0

Prerequisite: Permission of instructor.

General principles of insect toxicology and the chemistry and biological activity of insecticides. The laboratory work will consist of a series of chemical and biological experiments designed to illustrate and supplement the lecture material. Given 1954-55.

Mr. Gast.

Ent. 641. Seminar.

One credit per term

Prerequisite: Graduate standing in Entomology.

Scientific articles, progress reports in research, and special problems of interest to entomologists reviewed and discussed.

A maximum of three credits is allowed toward the Master's degree but any number toward the Doctorate.

Staff.

Ent. 651. Research.

Credit by arrangement

Prerequisite: Graduate standing in Entomology.

A maximum of nine credits is allowed toward the Master's degree, but any number toward the Doctorate.

Staff.

*Given in alternate years.

THE SCHOOL OF FORESTRY

Graduate Faculty

Professors: RICHARD JOSEPH PRESTON, Dean, JAMES SAMUEL BETHEL, ROY MERWIN CARTER, CLARENCE EARL LIBBY, T. EWALD MAKI.
Associate Professor: WILLIAM DYKSTRA MILLER.

Graduate work in forestry is offered through the Graduate School to meet the needs of two classes of students:

1. The professional degree of Master of Forestry or Master of Wood Technology is designed for students desiring a broad knowledge of the several branches of forestry with emphasis upon advanced professional specialization.

2. The degree of Master of Science in Forestry or in Wood Technology is designed for students desiring to enter fields of research or teaching. This degree requires a sound fundamental background in scientific courses and a carefully designed program of scientific research. A reading knowledge of one modern foreign language is required.

Candidates for the Master's degree will fall under one of the following categories.

1. Students with a bachelor's degree in forestry from a school of recognized standing. These students may secure the master's degree in one academic year of three quarters.

2. Students with a bachelor's degree, other than in forestry, from a college, university, or scientific school of high standing. These students may secure the master's degree in two academic years provided they have the requirements in botany, chemistry, and mathematics required in the freshman and sophomore years of the curricula. Candidates for the degree Master of Forestry or Master of Science in Forestry who do not hold an undergraduate degree in forestry must start their program with the summer camp.

3. Students not possessing a bachelor's degree may earn, through proper selection of courses, a Bachelor of Science degree in one of the forestry curricula at the end of the fourth year and a Master's degree in Forestry or Wood Technology at the end of the fifth year.

A wide and rapidly expanding field of employment possibilities is available in the Southeast to young men trained in forestry. Until recent years most job opportunities were with government agencies in managing our public forests, and this still constitutes a major source of employment. These agencies include state and federal forest services, extension services, and other groups such as the Soil Conservation Service and the Tennessee Valley Authority.

In recent years job opportunities with private industries have expanded greatly. Increasing numbers of technically trained young men are entering a wide variety of professional positions in the fields of forest land management, watershed management, logging, sawmilling, veneer and plywood manufacturing, pulp and papermaking, kiln drying, wood preservation, plastics and other chemical derivatives of wood, and the manufacture of wood products such as furniture, dimension stock, and various prefabricated items.

Graduate training offers tangible well-established values to young men of proven ability. The demand for men with advanced degrees in forestry has far exceeded the supply for many years.

Graduate preparation is essential for the corps of specialists which are needed in many fields. Training through the Master's degree is almost a requirement for men entering college teaching and public or industrial research. State and federal agencies as well as forest industries are employing research investigators at unprecedented levels.

The continuing rapid expansion of southern forestry has resulted in a corresponding expansion in the need for trained men. As a general rule most employers will prefer a candidate with graduate training. While forest industry and public forest administration does not normally require graduate training, increasing numbers of positions in these fields are being filled by men with advanced forestry degrees, particularly the Master's degree, and a man with the Master's degree has a distinct advantage over one without it.

A new \$850,000 Forestry-Horticulture building which will provide the School of Forestry with an outstanding physical plant has just been completed. The first floor houses portions of the Wood Products Laboratory and the second and third floors consist of laboratories, library, classrooms and offices.

The School of Forestry now owns, or has access to, over 90,000 acres of forest land located in six tracts and representing major forest types in the state. The largest tract is the Hofmann Forest on the coastal plain which is operated by the North Carolina Forestry Foundation for the benefit of the School of Forestry. The Hill Forest in Durham County, the Hope Valley Forest in Orange County, the Goodwin Forest in Moore County, and the Richlands Creek Farm Forest in Wake County includes representative types of the Piedmont area. The Long Creek Forest at Roaring Gap contains 11,000 acres of mountain forest types and the camp on this forest supple-

ments the previously established forestry camps on the Hofmann and Hill Forests and provides the School with permanent, well-equipped, modern camps in each of the three major regions of the state.

In the past two years one of the most modern and complete Wood Products Laboratories in the country has been developed in the area allocated to Forestry on Western Boulevard. Approximately \$150,000 has been invested in building and equipment; the major portion of this has been provided by grants from Manufacturers for equipment supplied on loan or consignment.

Courses for Advanced Undergraduates

- For. 401. Preservation and Waste Reduction.** 0-0-4
Factors causing wood deterioration; preservative materials and treatments; wood by-products from mill and forest waste. Mr. Stecher and Mr. Wyman.
- For. 402. Foundations of Forest Management.** 0-3-0
Prerequisites: For. 274 or For. 311.
The integration of silviculture, forest measurements and economics in the management of woodland areas. (Not open to students majoring in forest management). Mr. Bryant.
- For. 403. Paper Technology Laboratory.** 0-0-3
Development of various types of paper finishes with particular attention to stock preparation, sizing, filling, and coloring. The finished products are tested physically and chemically and evaluated from the standpoint of quality and in comparison with the commercial products they are intended to duplicate. Mr. Libby.
- For. 411, 412. Pulp and Paper Making Machinery.** 3-3-0
Principles of operation, construction and design of process equipment employed in the pulp and paper industry. Mr. Libby.
- For. 413. Paper Testing Laboratory.** 0-0-3
Physical, chemical, and microscopical examination of experimental and commercial papers and evaluation of the results in terms of the utility of the products tested. Mr. Libby.
- For. 421. Log and Lumber Grades and Specifications.** 3-0-0
Log and bolt grades and specifications in use; log grades based upon lumber grades; lumber grading principles and practices for hardwoods and softwoods. Mr. Wyman.
- For. 422. Forest Products.** 0-3-0
Prerequisites: For. 201, Chem. 203 or 426.
The source and method of obtaining derived and manufactured forest products other than lumber. Mr. Wyman.
- For. 423. Logging.** 3-0-0
Timber harvesting and transportation methods, equipment and costs; application of methods and mechanized equipment to specific conditions and regions; safety and supervision in logging. Mr. Wyman.
- For. 431. Naval Stores.** 0-3-0
Prerequisite: Chem. 203.
Methods of turpentine wood practices; factors influencing oleoresin yields; distilling practices; integration with other forest products utilization. Mr. Wyman.
- For. 432. Merchandising Forest Products.** 0-3-0
Principles and practices in the distribution and marketing of the products obtained from wood; organization and operation of retail, concentration and wholesale outlets. Mr. Carter.
- For. 433. Gluing and Plywood.** 3-0-0
Veneer manufacturing methods and equipment; veneer products; cold-press and hot-press bonding adhesives; processing and use requirements; cause and prevention of inadequate bonds; molded, flat and post-formed plywood construction. Mr. Bethel.

For. 441. Wood Machining and Equipment.

0-0-3

Prerequisites: For. 201, 303.

Machining characteristics of woods; knife and saw angles, speeds and feeds for various machines and wood conditions; machinery construction, operation, maintenance. Application of types of equipment to specific operations in furniture, plywood and other wood-working plants.

Mr. Bethel.

For. 442. Lumber and Dimension Stock Manufacturing.

3-0-0

Short and long log types of sawmills and milling practices; manufacturing methods and equipment for turned products, novelties, and special shaped dimension; manufacture and milling operations for hardwood dimension stock and softwood cut stock; transportation and handling methods.

Mr. Stecher.

For. 443. Wood Finishing.

0-0-3

Prerequisites: For. 201, Chem. 203 or 426.

Preparation of wood surfaces for finish coatings; composition and application of paints, varnishes, repellents, lacquers, and other wood finishing materials; finishing furniture and interior wood products.

Mr. Carter.

For. 451. Paper Coloring.

2-0-0

Evaluation and identification of dyestuffs and the development of color formulas for dyeing pulp and paper.

Mr. Libby.

For. 452. Forest Grazing.

0-0-3

Management of range areas, all grazing regions with special consideration of the south-east.

Mr. Maki.

For. 453. Lumber Structures.

0-3-0

Structural grades of lumber; working stresses; frame construction; construction estimates and computations; masonry, insulation, roofing and other structural materials; millwork; fastenings; prefabs.

Mr. Wyman.

For. 461. Paper Converting.

0-3-0

A survey of the principal processes by which paper and paper board are fabricated into the utilitarian products of everyday use.

Mr. Libby.

For. 462. Artificial Forestation.

0-3-0

Production, collection, extraction, and storage of forest tree seeds; nursery practice; field methods of planting.

Mr. Slocum.

For. 463. Mill Inspections.

0-0-1

One week inspection trip covering representative manufacturers of pulp and paper and papermaking equipment.

Mr. Libby.

For. 471, 473. Pulp Technology Laboratory.

3-3-0

Preparation and evaluation of the several types of wood pulp. The influence of the various pulping and bleaching variables on pulp quality are studied experimentally and these data evaluated critically.

Mr. Libby.

For. 472. Forest Policy and Administration.

3-0-0

Civil timber law, illustrated by court cases; state and federal forest policy; job-load analysis in national forest administration.

Mr. Miller.

For. 482, 483. Pulp and Paper Mill Management.

0-2-2

A survey of the economics of the pulp and paper industry is followed by a study of the work of the several departments of a paper mill organization and the functions of the executives who administer them.

Mr. Libby.

For. 491, 492. Pulp Testing Laboratory.

1-1-0

Evaluation of experimental and commercial wood pulps for such properties as color, bleachability, freeness, strength, viscosity, alpha cellulose content, etc.

Mr. Libby.

Courses for Graduates and Advanced Undergraduates

For. 501. Forest Valuation.

4-0-0

The theory and techniques of valuation of forest land, timber stands, and forest practices as investments and for appraisals of damages. The evaluation of risks and hazards in forestry as they apply to forest investments, forest insurance, and forest taxation.

Mr. Bryant.

For. 511. Regional Silviculture. 5-0-0

The principles and application of intermediate and reproductive methods of cutting; controlled burning, silvicides, and other methods of hardwood control. The application of silvicultural methods in the forests of the United States. Mr. Miller.

For. 512. Forest Economics. 0-3-0

Economic and social value of forests; supply of, and demand for forest products; land use; forestry as a private and a public enterprise; economics of the forest industries. Mr. Bryant.

For. 513. Tropical Woods. 0-0-3

Structure, Identification, Properties, characteristics and use of tropical woods, especially those used in plywood and furniture. Mr. Bethel.

For. 523. Furniture Construction and Assembly. 0-3-0

Prerequisites: For. 303, 322.

Stock preparation for gluing; selecting adhesives; types of metal fastenings; joint construction and methods of joining wood and other materials; assembly methods for furniture and other wood products; construction and strength properties of laminated members. Mr. Carter.

For. 531. Forest Management. 0-5-0

Prerequisite: For. 372.

Management of timber lands for economic returns; the normal forest taken as the ideal; the application of regulation methods to the forest. Mr. Maki.

For. 533. Advanced Wood Structure and Identification. 3-0-0

Prerequisite: For. 201.

Advanced microscopic identification of the commercial woods of the United States and some tropical woods; microscopic anatomical features and laboratory techniques. Mr. Slocum.

For. 541. Mechanical Properties of Wood. 3-0-0

Prerequisites: For. 201, 303.

Strength and related properties of commercial woods; standard A.S.T.M. strength tests; toughness; timber fastenings; structural requirements; working stresses. Mr. Wyman.

For. 542. Fiber Analysis. 3-0-0

Fiber microscopy; the determination of fiber measurement, quality, variation and identity in pulp woods. Mr. Bethel.

For. 543. Pulping Processes and Products. 0-3-0

Prerequisites: For. 201, Chem. 203 or 426.

Fiber manufacturing processes and equipment; wall, insulation and container board products; manufacture of roofing felts; pulp products manufacturing; resin treated and specialty products, lignin and wood sugar products. Mr. Libby.

For. 553. Forest Photogrammetry. 0-3-0

Interpretation of aerial photographs, determination of density of timber stands and area mapping. Mr. Slocum.

For. 563. Quality Control in Wood Product Manufacture. 0-0-3

Prerequisites: Stat. 461 or 412.

A study of methods used to control quality of manufactured wood products. Emphasis is placed on the use of control charts for variables and attributes and on acceptance sampling techniques including single, double and sequential sampling methods. Mr. Bethel.

For. 573. Methods of Research in Forestry. 0-0-3

Methods of procedures, problem outlines, presentation of results; consideration of selected studies by forest research organizations; sample plot technique. Mr. Maki.

For. 591, 592, 593. Forestry Problems. 1-5, 1-5, 1-5

Assigned or selected problems in the field of silviculture, logging, lumber manufacturing, pulp technology, or forest management. Graduate Staff.

Courses for Graduates Only

For. 601, 602, 603. Advanced Forest Management Problems. 1-5, 1-5, 1-5
Directed studies in forest management. Graduate Staff.

For. 611, 612, 613. Advanced Silviculture Problems. 1-5, 1-5, 1-5
Advanced problems or experiments in silviculture. Graduate Staff.

For. 621, 622, 623. Advanced Logging Problems. 1-5, 1-5, 1-5
Selected research in logging problems of an advanced nature. Graduate Staff.

For. 631, 632, 633. Advanced Lumber Manufacturing Problems. 1-5, 1-5, 1-5
Selected problems in the field of lumber, dimension stock, cut-stock and specialty products manufacture, seasoning and milling. Graduate Staff.

For. 641, 642, 643. Advanced Utilization Problems. 1-5, 1-5, 1-5
Problems of an advanced grade in some phase of forest utilization. Graduate Staff.

For. 651, 652, 653. Forest Valuation Problems. 1-5, 1-5, 1-5
Planning, organizing, and conducting, under general supervision, an important research project in one of the fields of valuation. Graduate Staff.

For. 661, 662, 663. Wood Fabrication Problems. 1-5, 1-5, 1-5
Original research and study on special projects directed toward problems in gluing, assembly, and machining or other phases of fabrication for a thesis. Graduate Staff.

For. 671, 672, 673. Problems in Research. Credits by arrangement
Specific forestry problems that will furnish material for a thesis. Graduate Staff.

For. 681. Graduate Seminar. 1-1-1
Prerequisite: Graduate standing in Forestry or closely allied fields.
Presentation and discussion of progress reports on research, special problems, and outstanding publications in forestry and related fields. Staff.

GENETICS

A UNIT OF THE DIVISION OF BIOLOGICAL SCIENCES

Graduate Faculty

Professors: STANLEY GEORGE STEPHENS, Head, CARY HOYT BOSTIAN.

Associate Professors: DANIEL SWARTWOOD GROSCH, BENJAMIN WARFIELD SMITH.

Associate Members of the Genetics Faculty:

Professors: FRED DEWARD COCHRAN, RALPH ERNEST COMSTOCK, EDWARD WALKER GLAZENER, WALTON CARLYLE GREGORY, PAUL H. HARVEY, GORDON KENNEDY MIDDLETON, HAROLD FRANK ROBINSON, HAMILTON ARLO STEWART.

Associate Professors: WARREN SANDUSKY BARHAM, GEORGE WILLIAM SCHNEIDER.

Assistant Professors: DAN ULRICH GERSTEL, JAMES EDWARD LEGATES, THURSTON JEFFERSON MANN.

Graduate study under direction of the Genetics Faculty may enable the student to qualify for the Master of Science or the Doctor of Philosophy degree. A candidate for the Master's degree must acquire a thorough understanding of genetics and its relation to other biological disciplines and must present a thesis based upon his own research. In addition to a comprehensive knowledge of his field, a candidate for the doctorate must demonstrate his capacity for independent investigation and scholarship in genetics.

At North Carolina State College there are no sharp divisions along departmental lines between theoretical and applied aspects of genetic research. The Members and Associate Members of the Genetics Faculty represent six different departments of the School of Agriculture. They are studying an extremely wide range of genetic problems and are utilizing materials which include *Habrobracon*, cattle, swine and poultry and most of the important agronomic and horticultural crop plants of the region. A graduate student has the opportunity to observe and to participate in this program. He may work in physiological genetics, statistical genetics, cytogenetics, irradiation genetics. He may study genetics as related to the problems of plant and animal breeding.

The Genetics Faculty is provided with offices and laboratories in the new Division of Biological Sciences Building, Gardner Hall. Adjacent to the building are a greenhouse and a genetics garden. The genetics program is most fortunate in that it can also draw upon the extensive facilities of the North Carolina Agricultural Experiment Station through the co-operation of the Associate Faculty Members in Agronomy, Animal Industry, Horticulture, Poultry Science, and Experimental Statistics.

Courses for Advanced Undergraduates

Gen. 411. The Principles of Genetics.

5-0 or 5

Prerequisites: Bot. 102 and Zool. 101.

Basic principles of heredity and variation. Students conduct breeding experiments and study inheritance in various animals and plants.

Messrs. Bostian, Grosch.

Courses for Graduates and Advanced Undergraduates

- Gen. 512. Genetics.** 0-3-0
 Prerequisite: Gen. 411.
 Intended for students desiring more thorough and detailed training in fundamental genetics than provided by Gen. 411, with some attention to recent advances. Mr. Grosch.
- Gen. 513. Cytogenetics I.** 0-5-0
 Prerequisite: Gen. 512 (or concurrent registration)
 Variations in the chromosomal mechanisms of inheritance and their genetic consequences. The chromosomes as they affect breeding behavior in plants and animals. Lecture and laboratory. Mr. Gerstel.
- *Gen. 520. Principles of Evolution.** 0-3-0
 Prerequisite: Gen. 512.
 The theory of evolution and its biological foundation. Forces responsible for evolution; the effects of variation, isolation and selection on genetic populations. Mr. Gregory.

Courses for Graduates Only

- †Gen. 614. Cytogenetics II.** 0-0-5(3)
 Prerequisite: Gen. 512. Recommended: Gen. 513.
 Cytogenetic processes in evolution and their analysis.
 Lecture and laboratory (optional). Mr. Smith.
- †Gen. 615. Cytology.** 3-0-0
 Prerequisite: Gen. 512.
 The organization and reproduction of nuclei and cells with consideration of the current theories of chromosome structure, mechanics, and behavior. Mr. Smith.
- †Gen. 616. Cytological Laboratory.** 2-0-0
 Prerequisite: Experience or class work in microtechnique; concurrent registration in Gen. 615.
 Cytological preparations and their analysis; demonstrations and student materials illustrating Gen. 615. Mr. Smith.
- *Gen. 620. Genetic Concepts of Speciation.** 0-0-3
 Prerequisites: Gen. 512 and 513.
 A review of the recent literature concerned with the nature of species and species formation. Mr. Stephens.
- †Gen. 633. Physiological Genetics.** 0-0-3
 Prerequisite: Gen. 512.
 Recent advances. Attention is directed to literature on the nature and action of genes, and to the interaction of heredity and environment in the expression of the characteristics of organisms. Mr. Grosch.
- *Gen. 634. The Genetic and Cytological Effects of Environmental Agents.** 0-0-3
 Prerequisite: Gen. 512.
 A review of the literature on the induction of changes in cytogenetic mechanisms by chemical and physical means with emphasis on analytical aspects. Mr. Grosch.

* Given in even years.

† Given in odd years.

Gen. 641. Research in Genetics.

Credits by arrangement

Prerequisite: Graduate standing in Genetics; consent of instructor.

A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate program. Staff.

Gen. 651. Seminar.

One credit per term

Prerequisite: Graduate Standing.

A maximum of three credits is allowed toward the Master's degree; no limitation on credits in Doctorate program. Staff.

The following courses are offered by cooperating departments and accepted for graduate credit in genetics.

A.I. 502. Animal Breeding

A.I. 626. Advanced Animal Breeding

Poul. 520. Poultry Breeding

Poul. 601. Advanced Poultry Genetics

Stat. 625, 626. Statistical Concepts in Genetics.

DEPARTMENT OF GEOLOGY

Graduate Faculty

Professor: JASPER LEONIDAS STUCKEY, Head.

Associate Professor: JOHN MASON PARKER, III.

The Department of Geology offers a program leading to the degree of Master of Science in Geological Engineering. Candidates should hold the degree of Bachelor of Geological Engineering or a satisfactory equivalent.

The solution of professional problems in geology, as in other fields today, is requiring more quantitative data and specialized training than can be included in an undergraduate curriculum. Graduate training makes professional advancement more sure and rapid. A person with such training in geology will find employment with oil and mining companies, governmental agencies, and educational and research institutions.

North Carolina State College is on the Piedmont Plateau near the edge of the Atlantic Coastal Plain. A great variety of problems in igneous, sedimentary and metamorphic geology are to be found within a radius of 50 miles of Raleigh.

Facilities are available for research in mineralogy, petrography, mineral dressing and problems relating to engineering. Excellent collections of geological literature are available at North Carolina State College, at the University at Chapel Hill and at Duke University in Durham.

Courses for Advanced Undergraduates

GEOLOGY

Geol. 412, 413. Economic Geology.

0-3-3

Prerequisites: Geol. 120 and 230; Chem. 103.

Required of seniors in Geological Engineering.

Mode of occurrence, association, origin, distribution, and uses of economically valuable minerals. Lectures, laboratories, and field trips. Mr. Stuckey.

† Given in odd years.

* Given in even years.

Geol. 443. Petrology.

0-4-0

Prerequisites: Geol. 120 and 230.

Required of juniors in Geological Engineering.

Materials of the earth's crust; composition, texture, classification, megascopic identification, and alterations of the principal igneous, sedimentary, and metamorphic rocks. Lectures, laboratories, and field trips.

Mr. Parker.

Geol. 462. Engineering Geology.

0-3-0

Prerequisite: Geol. 120.

Required of seniors in Geological Engineering.

The application of geologic principles to engineering practice: analysis of geologic factors and processes affecting specific engineering projects.

Mr. Miller.

Geol. 463. Geological Surveying.

0-0-4

Prerequisites: Geol. 351 and 443.

Required of seniors in Geological Engineering.

Methods of field observation and use of geologic surveying instruments in surface and underground work; representation of geologic features by maps, sections and diagrams.

Lectures, laboratories, and field work.

Messrs. Parker, Miller.

Courses for Graduates and Advanced Undergraduates

Geol. 510. Mineral Industry.

0-0-3

Prerequisite: Permission of Instructor.

Required in fifth year of Geological Engineering.

Economics of mineral industry. Cycles of mineral production. Exhaustibility. Reserves. Valuation of mineral property. National resources; essential, critical, and strategic minerals. World distribution and production.

Messrs. Parker, Steel.

Geol. 515. Petroleum Geology.

0-0-3

Prerequisite: Geol. 351 and 443.

Required in fifth year of Geological Engineering.

Properties, origin and modes of occurrence of petroleum and natural gas. Geologic and economic features of the principal oil and gas fields, mainly in the United States.

Staff.

Geol. 522. Stratigraphy and Index Fossils.

0-3-0

Prerequisite: Geol. 323.

Required in fifth year of Geological Engineering.

Character, distribution, sequence, correlation and conditions of origin of the major sedimentary formations in the southeastern U. S. Key fossils characteristic of each period. Lectures, laboratories and field trips.

Staff.

Geol. 531, 532. Optical Mineralogy.

3-3-0

Prerequisites: Geol. 230 and Phys. 203.

Required of seniors in Geological Engineering and in fifth year of Ceramic Engineering.

Optical principles involved in the petrographic (polarizing) microscope and related instruments. Microscope determination of minerals in thin section and in fragments. Lectures and laboratory work.

Messrs. Stuckey, Parker, Steel.

Geol. 551. Sedimentation.

3-0-0

Prerequisite: Geol. 443.

Required in fifth year of Geological Engineering.

Formation of sediments and sedimentary rocks, including their kinds, structures, sources, transportation, mode and environment of deposition.

Mr. Parker.

- Geol. 553, 554. Geophysics.** 0-3-3
 Prerequisites: Geol. 351, Phys. 203.
 Required in fifth year of Geological Engineering.
 Discussion of the fundamental principles underlying all geophysical methods; procedure and instruments involved in gravitational, magnetic, seismic, electrical and other methods of studying geological structures and conditions; study of applications and interpretations of results.
 Mr. Miller.
- Geol. 571, 572, 573. Mining and Mineral Dressing.** 3-3-3
 Prerequisite: Geol. 470.
 Required in fifth year of Geological Engineering.
 Principles of the mineral industry; mining laws, prospecting, sampling, developments, drilling, blasting, handling, ventilation and safety; administration, surveying, assaying; preparation dressing and marketing.
 Mr. Miller.
- Geol. 580. Geomorphology.** 3-0-0
 Prerequisite: Geol. 443.
 A systematic study of land forms and their relations to processes and stages of development and adjustment to underlying structure. Lectures, map interpretations, and field trips.
 Mr. Steel.

Courses for Graduates Only

- Geol. 611, 612. Advanced Economic Geology.** 3-3-0
 Prerequisites: Geol. 412, 413.
 Required in fifth year of Geological Engineering.
 Detailed study of the origin and occurrence of specific mineral deposits.
 Mr. Stuckey.
- Geol. 633. Microscopic Determination of Opaque Minerals.** 0-0-3
 Prerequisites: Geol. 332 and 532.
 Identification of metallic, opaque minerals in polished sections by physical properties, etch reactions and microchemical tests. Laboratories.
 Mr. Steel.
- Geol. 643. Advanced Petrography.** 0-0-3
 Prerequisites: Geol. 443, 532.
 Application of the petrographic microscope to the systematic study of the composition and origin of rocks; emphasis on igneous and metamorphic rocks.
 Messrs. Stuckey, Parker.
- Geol. 681, 682, 683. Seminar.** 1-1-1
 Prerequisite: Graduate standing.
 Scientific articles, progress reports and special problems of interest to geologists and geological engineers discussed.
 Staff.
- Geol. 691. Geological Research.** Credits by arrangement
 Prerequisite: Permission of the Instructor.
 Lectures, reading assignments, and reports; special work in Geology to meet the needs and interests of the students.
 Staff.

DEPARTMENT OF HISTORY AND POLITICAL SCIENCE

Graduate Faculty

Professor: PRESTON WILLIAM EDSALL.

No graduate degrees are offered in history or political science at State College. Graduate programs leading to advanced degrees in this field are offered at the University of North Carolina at Chapel Hill. The courses listed below are eligible for graduate credit when they form a part of an approved graduate program in other departments.

Courses for Graduates and Advanced Undergraduates

Pol. Sc. 501. Modern Political Theory. 3-0-0

Prerequisite: Consent of the instructor.

A study of the state and its relationship to individuals and groups, approached through the reading of selected passages from the works of outstanding political philosophers from the sixteenth century to the present.
Mr. Edsall.

Pol. Sc. 502. Public Administration. 0-3-0

Prerequisite: Consent of the instructor.

A study of the principles and problems of administration in a democracy, including such matters as organization, personnel, fiscal management, relationship to the legislative and judicial functions, control of administrative agencies and policies, and public relations.
Mr. Edsall.

Pol. Sc. 503. International Organization. 0-0-3

Prerequisite: Consent of the instructor.

A study of the evolving machinery and techniques of international organization in the present century with particular emphasis on recent developments. The actual operation of international organization will be illustrated by the study of selected current international problems.

Hist. 534. (Same as Rural Soc. 534). Farmer's Movements. 0-0-3

The origin, growth, and present status of such national farmers' organizations and movements as the Grange, the Farmers' Alliance, the Populist Revolt, the Farmers' Union, the Farm Bureau, the Society of Equity, the Nonpartisan League, and cooperative marketing.
Mr. Noblin.

DEPARTMENT OF HORTICULTURE

Graduate Faculty

Professors. MONROE EVANS GARDNER, Head, FRED DEWARD COCHRAN, JR., JOHN LINCOLN ETHELLE, IVAN DUNLAVY JONES.

Associate Professors: WARREN SANDUSKY BARHAM, EDGAR WARREN MC-ELWEE, EMMETT BROWN MORROW, GEORGE WILLIAM SCHNEIDER.

The Department of Horticulture offers the Master of Science degree and the professional degree Master of Horticulture. The requirements of each of these degrees are outlined in an earlier section of this catalog. Students applying for graduate study in Horticulture are expected to have an undergraduate major in this field. Evidence of high scholastic achievement in the basic biological sciences is particularly desirable for students who expect to study for the Master of Science degree.

The department now has one of the best physical plants in the south for training in Horticulture. The new building, completed in 1952, to house Horticulture and Forestry, contains adequate office, classroom, and laboratory space and the equipment necessary for a well rounded graduate program. The departmental library, which supplements the main library, contains about twenty-five thousand technical and popular bulletins, and current periodicals covering all phases of Horticulture. In addition complete volumes of the Proceedings of the American Society for Horticultural Science, Horticultural Abstracts and others.

A new greenhouse range is available which contains ten separate 24' x 30' compartments especially designed for research. This addition to the present range will make available for research and teaching approximately 25,000 sq. ft. of glass. A modern and well equipped processing laboratory is located on the first floor of the new building with adjoining analytical and bacteriological laboratories. This will provide facilities for research and teaching in the preservation of foods by quick-freezing, canning and other methods. Nine cold storage compartments will make possible extensive investigations dealing with the storage and handling of fruits, vegetables, and ornamentals. Out-field research problems are conducted on the student laboratory farm at Raleigh and at ten of the branch stations and laboratories located in the various geographical sections of the state.

Geographically, North Carolina occupies a position which is unique among the states of the nation. The East-West axis is over five hundred miles long and extends from the surf of the Atlantic to the highest peak east of the Rocky Mountains. Sub-tropical conditions exist in certain of the coastal areas while the altitude of western mountains give conditions comparable to the New England states. These varied conditions of soil and climate make it possible to produce, somewhere within the borders of the state, practically all of the crops which can be grown in the temperate zone.

The opportunities for employment after advanced training are many and varied: teaching and research in state and privately endowed institutions; research positions with U.S.D.A. both foreign and domestic; extension specialists and county agents; research and promotional work with food, chemical, and seed concerns; orchard, nursery and greenhouse supervisors; food technologists and inspectors.

Courses for Advanced Undergraduates

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|--|----------------|
| Hort. 402. Ornamental Plants. | 0-2-0 |
| The characteristics of ornamental plants used in landscape planting. | Mr. Schmidt. |
| Hort. 403. Landscape Gardening. | 0-0-3 |
| Prerequisite: Hort. 402 or equivalent. | |
| The elementary principles of design and the adaptation, use and maintenance of plant materials in landscape planting as applied to home grounds improvement. | Mr. Harris. |
| Hort. 421. Commercial Fruit Production. | 5-0-0 |
| Principles underlying the commercial production of tree fruits. Field trips are required. | |
| | Mr. Schneider. |
| Hort. 422.** Small Fruits Production. | 0-3-0 |
| Prerequisites: Hort. 101. | |
| Principles underlying the commercial production of grapes, strawberries, blueberries, raspberries, dewberries and other small fruits. | Mr. Morrow. |



Developing Tomato Varieties Resistant to Bacterial Wilt.

Hort. 431, 432, 433. Commercial Vegetable Growing.

3-3-3

Prerequisite: Hort. 303.

A study of commercial vegetable crops involving classification, production, physiology, and nutrition. Field trips are required. Mr. Schmidt.

Hort. 441, 442, 443. Commercial Floriculture.

3-3-3

Prerequisite: Hort. 313.

A study of the commercial production of cut-flower and pot-plant crops in the greenhouse, in other structures and in the field. Field trips are required. Mr. Randall.

Courses for Graduates and Advanced Undergraduates

Hort. 501, 502, 503. Horticultural Problems. Credits by arrangement

Prerequisite: B average and permission of instructor.

A systematic investigation of some phase of horticulture, each student choosing his own subject of study and pursuing it under the direction of the instructor. The problem may last from 1 to 3 quarters.

Credits will be determined by the nature of the problem, not to exceed a total of 6 hours. Staff.

Hort. 512.* Handling and Storage of Ornamental Plants. 0-3-0

Prerequisite: Bot. 421.

A study of the physiological principles involved in the handling and storage of ornamental plants. Staff.

Hort. 521, 522, 523. Technology of Fruit and Vegetable Products. 4-4-4

Prerequisite: Bot. 412.

Comprehensive treatment of principles and methods of preservation of fruits and vegetables including small scale plant operations and commercial processing plant visitations. Inspection, grading and judging of processed fruits and vegetables. Field trips are required. Mr. Jones.

Hort. 532.* Advanced Commercial Fruit Production. 0-3-0

Prerequisite: Hort. 421 and Bot. 421.

A thorough study of specific phases of fruit production. Mr. Schneider.

Hort. 542. Breeding of Horticultural Plants. 0-3-0

Prerequisite: Gen. 411.

The application of genetics and plant breeding to the improvement of horticultural crops. Mr. Barham.

Hort. 562.* Handling and Storage of Fruits and Vegetables. 0-3-0

Prerequisite: Bot. 421.

A study of the physiological and chemical changes which occur as a result of handling and storage of fruit and vegetable crops. Mr. McCombs.

Courses for Graduate Students

Hort. 601. Advanced Vegetable Crops.** 3-0-0

A study of current literature dealing with cultural, physiological and biochemical problems in Vegetable Crops. Mr. Cochran and Staff.

Hort. 602. Advanced Ornamental Crops.** 0-3-0

The application of research to the production of the major ornamental crops. Staff.

Hort. 603.* Advanced Pomology.

0-0-3

A critical study of specific problems in fruit production including pertinent current literature.
Mr. Schneider and Staff.

Hort. 611.* Methods and Evaluation of Horticultural Research.

4-0-0

A study of methods and procedure, outlining problems, assembling and analyzing data, and presenting results; critical review of research work.

Mr. Morrow and Staff.

Hort. 612. Advanced Fruit and Vegetable Processing.**

0-3-0

A critical study of certain processing methods as applied to fruit and vegetable preservation.
Mr. Jones.

Hort. 621. Research.

Credits by arrangement

Graduate students will be required to select problems for original research in ornamental, fruit or vegetable crops, or in food processing. The work and presentation of results should be of such merit as to be worthy of publication.

A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs.
Staff.

Hort. 631. Seminar.

Credits by arrangement

Assignment of scientific articles of interest for review and discussion.

A maximum of three credits is allowed toward the Master's degree but, any number toward the Doctorate.
Mr. Gardner.

**DEPARTMENT OF INDUSTRIAL ARTS
AND
DEPARTMENT OF INDUSTRIAL EDUCATION
See Education**

DEPARTMENT OF INDUSTRIAL ENGINEERING

Industrial Engineering is a relatively new branch of engineering that combines a knowledge of how industry is organized and operated with a basic training in the fundamentals of engineering. Graduate study leading to the Master of Science degree in Industrial Engineering is offered in this department. The rapid development of industry in North Carolina in recent years has opened many opportunities for men trained in plant operation and management.

Courses for Advanced Undergraduates

I. E. 408. Production Control.

0-0-4

Prerequisite: I. E. 332.

Required of juniors in I. E. and seniors in Furniture Manufacturing and Management.

Planning, scheduling, routing, and dispatching in manufacturing operations; production control systems; mechanisms for production control. Class projects will include organization of a complete production control system starting with a parts analysis from the working drawings of a production item.
Mr. Llewellyn.

* Offered in 1953-54 and in alternate years.

** Offered in 1954-55 and in alternate years.

I. E. 423. Job Evaluation.

Prerequisite: Senior standing.

3-0-0

Required of seniors in I. E. and Furn. Mfg. and Mgt.

Theory and practice of determining the relative money value of jobs within an organization and in localities; job analysis, classification and specification, ranking and grading systems, point systems, building the rate structure, application of merit rating. Factors pertaining to worker and union cooperation.

Mr. Furlong.

I. E. 425. Sales and Distribution Methods.

0-3-0

Prerequisite: Senior standing.

An analysis of the fundamental problems of distribution including application of engineering principles to problems; development and marketing of products; merchandising the product; and establishment of sales training programs.

I. E. 433. Wage Administration.

0-3-0

Prerequisite: Senior standing.

Required of seniors in I. E. and Furn. Mfg. and Mgt.

Scientific design, installation, and operation of extra financial incentive plans; analysis and comparison of different types of plans bringing out the characteristics which determine suitability for specific types of operations. Consideration of technique, methods, and administration of wage and salary structures.

Mr. Furlong.

I. E. 443. Quality Control.

0-0-3

Prerequisite: Stat. 361 and Senior standing.

Required of seniors in I. E. and Furn. Mfg. and Mgt.

Economic balance between cost of quality and value of quality, and techniques of accomplishing this balance; organization for quality, specification of quality, measurement, acceptance attributes, probability theory and statistical analysis as applied to sampling, control charts, tolerance determination, and acceptance procedures, and control of production.

Messrs. Furlong, Henderson.

I. E. 451, 452, 453. Seminar.

1-1-1

Prerequisite: Senior standing.

Required of seniors in I. E. and Furn. Mfg. and Mgt.

Current problems of interest to industrial engineers.

Staff.

Courses for Graduates and Advanced Undergraduates

I. E. 515. Process Engineering.

3-0-0

Prerequisites: I. E. 328, I. E. 343, I. E. 443.

Application of industrial engineering planning functions to the selection, layout, tooling and methods, standards, cost and control features of proposed products. Development of selected problem in laboratories.

I. E. 535. Material Handling.

0-0-3

Prerequisite: I. E. 408.

Principles, equipment and evaluation of material handling in industry. Shipping, receiving and warehousing. Plant surveys and organization for materials handling.

I. E. 541, 542. Advanced Motion and Time Study.

3-3-0

An advanced investigation of methods of determining time standards. Study of motion-time data and their use in setting standards. Theory and practice in determining allowances. Project work with comparative methods of setting standards for typical manufacturing operations. Detailed study of methods to increase productivity by analysis of operator movements.

I. E. 551, 552. Standard Cost and Budgeting.

0-3-3

Prerequisites: I. E. 301, 332.

Application of engineering methods to establishment of standard cost systems and budgets. Laboratory work with controlled shop conditions.

I. E. 581, 582, 583. Project Work.

2-2-2

Prerequisite: Graduate standing.

Research and investigation for students enrolled in the fifth-year curriculum in Industrial Engineering.

Courses for Graduates Only

I. E. 635, 636. Planning for Production.

3-3-0

Prerequisite: I. E. 408.

A study of the factors to be considered in developing an efficient and realistic plan of production for a manufacturing company. Analysis of sales demands. Market trends and business conditions. Construction of long range production schedules and finished goods inventory controls. Planning for material purchasing, equipment acquisition and labor requirements. Economic and cost factors of inventory turnover rates and control of inventories.

I. E. 671, 672, 673. Seminar.

1-1-1

Prerequisite: Graduate Standing.

Advanced problems in Industrial Engineering.

I. E. 691. Industrial Engineering Research.

Credits by arrangement

DEPARTMENT OF MATHEMATICS

Professors: HILBERT ADAM FISHER, Head, ROBERTS COZART BULLOCK, JOHN WESLEY CELL, JOHN MONTGOMERY CLARKSON, JACK LEVINE, CAREY GARDNER MUMFORD, LOWELL SHERIDAN WINTON.

Associate Professors: CHARLES LEMUEL CARROLL, PAUL E. LEWIS, HOWARD M. NAHIKIAN, HUBERT VERN PARK, CHARLES FREDERICK STROBEL.

Graduate Faculty

The Department of Mathematics offers graduate programs leading to the Master of Science degree in applied mathematics. Knowledge of advanced mathematics has become essential for graduate study in most of the departments of a technological institution such as State College. This is particularly true of the several fields of engineering, physics, statistics, and the biological sciences. The faculty in Mathematics at State College is exceptionally well-trained and presents opportunities for graduate study in a number of the important special areas of mathematics.

Statistical laboratories, Government agencies, such as the Bureau of the Census, Actuarial departments of Insurance companies, Technical Laboratories like the Oak Ridge Institute for Nuclear Research, and many other organizations have a growing need for personnel trained in applied Mathematics. Academic positions are constantly opening for teachers with, usually, a minimum requirement of a Master's degree. In the field of Engineering, more and more opportunities for Mathematically trained men are being brought to light.

Courses for Advanced Undergraduates

Math. 401. Differential Equations.

3-0-0

Prerequisite: Math. 303.

Required of juniors in Electrical Engineering and elective for others.

Solution of standard types of equations; numerous examples in the field of Electrical Engineering. Staff.

Math. 402. Theory of Equations.

0-3-0

Prerequisite: Math. 303.

Elective.

The usual topics in the theory of equations, the solution of higher equations, exponential equations, logarithmic equations, and determinants. Staff.

Courses for Graduates and Advanced Undergraduates

Math. 501. Graphical and Numerical Methods.

3-0 or 3

Prerequisite: Math. 303.

Elective.

Construction of scales to represent functions, including the construction of some special purpose slide rules and networks. Alignment charts; theory of least squares and empirical curve fitting, including periodic functions. The error curve and some of its properties. Numerous examples in the field of engineering will be solved. Graduate Staff.

Math. 502. Advanced Numerical Analysis.

0-3-0

Prerequisites: Math. 401, Math. 501.

Newton and Lagrange interpolation formulas, divided differences, sub-tabulation. Advanced topics in curve fitting. Graphical and numerical methods for solving ordinary and partial differential equations.

Graduate Staff.

Math. 511. Advanced Calculus for Engineers.

3-0-0

Prerequisite: Math. 401.

Elective.

Continuity; Taylor's series with remainder; differentials, power series, directional derivative; implicit functions; Jacobians; differentiation of integrals; improper integrals; hyperbolic functions. Applications to problems in engineering. Graduate Staff.

Math. 512. Advanced Calculus for Engineers.

0-3-0

Prerequisite: Math. 511.

Elective.

A continuation of the work in Math. 511. Differentiation of integrals; improper integrals; gamma and beta functions; line integrals. Green's theorem, Stokes' theorem; maximum and minimum points on a surface. Applications to problems in engineering. Graduate Staff.

Math. 513. Advanced Calculus for Engineers.

0-0-3

Prerequisite: Math. 512.

Elective.

Introduction to the theory of functions of a complex variable, including simple mapping problems, contour integration and residue theory; review of tests for convergence; series solutions of differential equations; expansion of functions in Fourier series. Graduate Staff.

- Math. 514. Boundary Value Problems.** 3-0-0
 Prerequisite: Math. 513.
 Ordinary homogeneous and non-homogeneous differential equations with boundary values; characteristic functions; applications of Fourier series and other methods to the solution of certain boundary value problems in partial differential equations. Graduate Staff.
- Math. 521. Advanced Analytic Geometry.** 3-0-0
 Prerequisite: Math. 303.
 The elements of space geometry; quadric surfaces; general equation of the second degree and its reduction to canonical form; translations and rotations in space; elements of higher plane curves and space curves. Graduate Staff.
- Math. 522. Theory of Probability.** 0-3-0
 Prerequisite: Math. 401.
 Definitions and fundamental relations. Binomial and multinomial distributions, Poisson and normal distributions, probability integral, Mathematical Expectation, Bayes' Theorem. Applications to problems in engineering and statistics. Graduate Staff.
- Math. 532. Advanced Differential Equations.** 0-3-0
 Prerequisite: Math. 401.
 Solution of circuit problems by impedance methods; hyperbolic functions of complex quantities and applications; series solutions of differential equations; Bessel functions; operational methods of solving differential equations; introduction to solution of partial differential equations and applications. Graduate Staff.
- Math. 533. History of Mathematics.** 0-0-3
 Prerequisite: Math. 303.
 Elective.
 A study will be made of the lives and contributions of certain outstanding mathematicians as representative of eras in the historical development of mathematics. Graduate Staff.
- Math. 541. Vector Analysis.** 3-0 or 3
 Prerequisite: Math. 401.
 Elective.
 The algebra of vectors with various vector products and applications; the calculus of vectors; partial differentiation; integration; applications to engineering problems. Graduate Staff.
- Math. 542. Advanced Vector Analysis.** 0-3-0
 Prerequisite: Math. 541.
 A continuation of Math. 541. General coordinates, irrotational and solenoidal vectors, harmonic functions, linear vector functions, applications. Graduate Staff.

Courses for Graduates Only

- Math. 602. Ordinary and Partial Differential Equations.** 0-3-0
 Prerequisite: Math. 512.
 Solution of ordinary differential equations by simple operational methods; partial differential equations; functions arising from solution of differential equations; applications to problems arising in electrical, civil, and mechanical engineering. Mr. Mumford.

- Math. 603. Ordinary and Partial Differential Equations.** 0-0-3
 Prerequisite: Math. 602.
 A continuation of the work in Math. 602. Fourier series and solution of problems in vibrations, heat flow, and electricity; reducible and irreducible homogeneous equations; theory of harmonic functions, Poisson's integral, and boundary value problems. Mr. Mumford.
- Math. 604. Orthogonal Functions.** 0-3-0
 Prerequisite: Math. 513 or consent of instructor.
 The development of the theory and properties of general orthogonal functions; applications to Fourier, Bessel, Legendre, Hermitian, Laguerre, and Tchebycheff types of orthogonal functions. Methods developed here will be used in the solution of problems from physics and engineering. Mr. Carroll.
- Math. 611. Complex Variable Theory and Applications.** 3-0-0
 Prerequisite: Math. 513.
 Elementary functions; analytic functions and Cauchy-Riemann equations; conformal mapping and applications to field theory and flow phenomena; Taylor and Laurent series; contour integration and residue theory. Mr. Bullock.
- Math. 613. Advanced Complex Variable Theory and Applications.** 0-0-3
 Prerequisite: Math. 611.
 A continuation of Math. 611. Further development of theory on series, analytic continuation; mapping and the Schwartz-Christoffel transformation; applications to flow problems and other problems in engineering. Mr. Bullock.
- Math. 621. Advanced Geometry.** 3-0-0
 Prerequisite: Math. 511.
 A study of geometry from an advanced standpoint. Foundations of geometry. Geometric transformations. Invariants under transformations. Applications of geometric methods to analyzing singularities. Geometric constructions. Mr. Clarkson.
- Math. 622. Advanced Algebra.** 0-3-0
 Prerequisite: Math. 303.
 Determinant and matrix theory; transformations; quadratic forms; characteristic equation. Messrs. Nahikian, Strobel.
- Math. 623. Calculus of Finite Differences and Difference Equations.** 0-0-3
 Prerequisite: Math. 401.
 Symbolic methods; generating functions; factorial, gamma, and beta functions; binomial coefficients; methods of summation; the numbers and polynomials of Bernoulli, Boole, Euler, Stirling; interpolation; difference equations. Mr. Carroll.
- Math. 632. Operational Mathematics.** 0-3-0
 Prerequisite: Math. 611.
 Fourier integral and applications; Laplace transform and applications to solution of differential equations arising from engineering problems. Mr. Cell.

- Math. 633. Advanced Operational Mathematics.** 0-0-3
 Prerequisite: Math. 632.
 Extended development of the theory of the Laplace transform; further applications to engineering problems. Mr. Cell.
- Math. 641. Calculus of Variations and Applications.** 3-0-0
 Prerequisite: Math. 401.
 Necessary and sufficient conditions for existence of an extremum for an integral which is a function of one or several independent variables; specific examples such as the brachistochrone problem; Hamilton's principle and the principle of least action; brief consideration of the isoperimetric problem and the variable end-point problem. Mr. Winton.
- Math. 651. Expansion of Functions.** 3-0-0
 Prerequisites: Math. 611, 632.
 Expansion of functions of one or several variables in Taylor series; asymptotic series, infinite products, partial fractions, continued fractions, series of orthogonal functions. Applications in engineering will be included. Mr. Cell.
- Math. 661. Tensor Analysis I.** 3-0-0
 Prerequisites: Math. 512, 541, 602.
 Recommended (but not required) Math. 521, 542, 622.
 The basic theory. Tensor algebra, tensor calculus. Invariant theory. Quadratic differential forms, covariant differentiation, curvature tensor. Geometric applications, Riemannian spaces, parallelism, geodesics, normal coordinates. Generalized vector analysis. Mr. Levine.
- Math. 662. Tensor Analysis II.** 0-3-0
 Prerequisite: Math. 661.
 Physical applications: (1) Dynamics. Lagrange's equations, generalized coordinates. The geometry of dynamics, kinematic and action line elements. Holonomic and non-holonomic systems. Configuration space. Dynamics in n -dimensions. (2) Elasticity. Finite strains, equations of compatibility, strain invariants, stress tensor, equations of motion, generalized Hooke's law, isotropic stress-strain relations. (3) Hydrodynamics. Perfect fluids, viscous fluids, viscosity tensor. Navier-Poisson-Duhem equations of motion. Mr. Levine.
- Math. 663. Tensor Analysis III.** 0-0-3
 Prerequisite: Math. 662.
 Further physical applications. (1) Electromagnetic theory. Maxwell's equations, plane waves, stress-energy tensor. (2) Relativity. Lorentz transformation, field equations. Schwarzschild solution, planetary orbits, unified field theories. Non-riemannian spaces. Mr. Levine.
- Math. 681, 682, 683. Special Topics in Mathematics.** 3-3-3
 Prerequisite: Math. 602 or Math. 632.
 Elective.
 This course provides an opportunity for small groups of graduate students to study, under the direction of qualified members of the professional staff, advanced topics in their special fields of interest. Graduate Staff.
- Math. 691. Research in Mathematics.** Credits by arrangement
 Prerequisite: Graduate standing and approval of adviser.
 Individual research in the field of mathematics.

DEPARTMENT OF MECHANICAL ENGINEERING

Graduate Faculty

Professors: KARL P. HANSON, Head, JESSE SEYMOUR DOOLITTLE, NORVAL WHITE CONNER, ELMER GEORGE HOEFER, ROBERT MCLEAN PINKERTON.

The Department of Mechanical Engineering offers graduate work leading to the degree of Master of Science in Mechanical Engineering and Master of Science in Mechanical Engineering Aeronautical Option. Admission for graduate study leading to the Master's degree is based upon an undergraduate major in engineering. In general, the specific fields in Mechanical Engineering are:

(1) Heat Power, including thermodynamics, heat transfer, power generation, steam and gas turbines, refrigeration, heating and air conditioning;

(2) Design, including analysis of machines and stresses occurring in machine parts, experimental stress analysis, lubrication, and metallurgy;

(3) Aeronautics, including aerodynamics, instrumentation, and aircraft structures.

In addition to the above, students may select courses from other departments to supplement their work in allied fields of engineering mechanics, electrical engineering, mathematics, and physics.

Excellent physical facilities are available to carry on an extensive graduate program in the various fields in Mechanical Engineering. Equipment which can be used in connection with experimental projects and thesis work includes steam turbines, air compressors, fans, blowers, heat transfer equipment, balancing machines, and refrigeration units. There is much equipment available for specific research and laboratory investigations in the fields of air conditioning, heat transfer, fluid flow, wind tunnel investigations, aircraft instrumentation, various experimental methods of stress analysis, and metallographic and metallurgical investigations.

Adequate physical space in a new and modern building is available for setting up research projects.

Many opportunities exist for men who are interested in additional training of a professional nature and particularly those interested in the fields of design, research, and education, as well as those who may be interested in carrying on their education beyond the Master's level. There is an urgent demand for people in academic work as well as industry for men with advanced training at the Master of Science level.

Several assistantships are available in the department for half time graduate work and half time work in the department of a teaching or research nature. It is expected that an assistantship student will obtain his Master of Science degree in two years. (See announcement pertaining to fellowships and assistantships elsewhere in this catalog.)

Courses for Advanced Undergraduates

M. E. 401, 402, 403. Power Plants.

3-3-3

Prerequisite: M. E. 309.

Required of seniors in Mechanical Engineering.

Fuels and combustion: heat balance, steam boilers, prime movers, and auxiliaries, as applied to power generation. Messrs. Hanson, Lee.

- M. E. 407, 408, 409. Mechanical Engineering Laboratory II.** 1-1-1
 Prerequisites: For M. E. 407: M. E. 315; for M. E. 409: M. E. 323.
 Required of seniors in Mechanical Engineering.
 Advanced study and tests in the fields of power plants, heating and ventilation, metallurgy, fluid flow, compressed air, fuels and combustion, and lubrication. Messrs. Bridges, Austin.
- M. E. 411, 412, 413. Machine Design.** 3-3-3
 Prerequisites: For M. E. 411: M. E. 319, E. M. 321; for M. E. 412: E. M. 422, M. E. 411.
 Required of seniors in Mechanical Engineering.
 A study of the methods of designing machine elements to withstand steady and varying forces and to operate without excessive wear at friction areas. Elementary stress analysis is followed by combined stresses, applied to such elements as screws, tanks, keys, shafts, springs, bearings, belting, clutches, brakes, frames, and gears. Messrs. Faires, Hoefler.
- M. E. 461, 462, 463. Experimental Engineering.** 3-3-3
 Prerequisites: M. E. 315 or equivalent as approved by instructor.
 Advanced engineering principles applied to a specific project dealing with heat, power, hydraulic machinery, metallography, aerodynamics, or general experimental work. A seminar period is provided, and a written report is required. Staff.
- M. E. 491, 492, 493. Technical Seminar.** 1-1-1
 Prerequisite: Junior or senior standing.
 Elective for juniors or seniors in M. E.
 Meetings once a week for the delivery and discussion of student papers on topics of current interest in Mechanical Engineering. Mr. Hanson.

Courses for Graduates and Advanced Undergraduates

- M. E. 517. Advanced Kinematics.** 0-3-0
 Prerequisite: M. E. 319.
 A further study of velocity and acceleration of mechanisms. Helical, Spiral Bevel, and Hypoid Gears are analyzed and designed kinematically. Several special mechanisms are also studied. Mr. Faires.
- M. E. 525, 526. Experimental Stress Analysis.** 3-3-0
 Prerequisites: M. E. 319; E. M. 321.
 The study of stress determination in machine elements experimentally by Photoelasticity, Electric and Mechanical Strain Gauges, Brittle Coating and other means. The correlation between photoelastic studies and the endurance limit of materials as applied to design stresses is considered. Mr. Whitfield.
- M. E. 527. Lubrication.** 0-0-3
 Prerequisite: M. E. 412.
 The comprehensive study of viscosity, viscosimetry, oilness, friction of perfectly and imperfectly lubricated surfaces. The theory of viscous and boundary lubrication and of bearing design from the standpoint of lubrication are covered. Mr. Neals.
- M. E. 541, 542, 543. Physical Metallurgy.** 3-3-3
 Prerequisite: M. E. 323.
 Theories concerning behavior and control of engineering alloys, reaction rates in the solid state and alloy influences; current heat treating practices; surface treatments; behavior of metals at high and low temperatures; special purpose alloys; powder metallurgy; review of modern equipment and methods for the study of metals. Messrs. Austin, Stadelmaier.

- M. E. 545. Metallurgical Factors in Design.** 0-3-0
Prerequisite: M. E. 323.
Study of the metallurgical factors that must be considered in using metals in design. Mr. Austin.
- M. E. 551, 552, 553. Project Work in Mechanical Engineering.** 2-2-2
Individual or group assigned design, construction, analytical or experimental projects in Mechanical Engineering. Staff.
- M. E. 555. Heating and Air-Conditioning.** 3-0-0
Prerequisite: M. E. 309.
Principles of heating and ventilation; warm air, steam, and hot-water heating systems air-conditioning. Mr. Knight.
- M. E. 556. Refrigeration.** 0-3-0
Prerequisite: M. E. 309.
An analysis of the simple, compound, centrifugal and multiple effect compression system, the steam jet and the absorption systems of refrigeration. Mr. Knight.
- M. E. 575. Steam Turbines.** 3-0-0
Prerequisite: M. E. 309 or M. E. 373.
The application of thermodynamics to steam turbines of both the impulse and reaction types. The flow of the steam is studied in both the nozzles and blades, with particular emphasis on energy transformations. Mr. Lee.
- M. E. 576. Gas Turbines.** 0-3-0
Prerequisite: M. E. 309.
The application of thermodynamics to gas turbines. The theoretical cycle is first reviewed and then modifications are made to account for imperfections in the compressor, turbine and combustor. The effects of regeneration and compounding are evaluated. Mr. Lee.
- M. E. 577. Heat Transfer.** 0-0-3
Prerequisite: M. E. 308 or M. E. 373.
A study of the various methods of heat transfer both in the steady and unsteady states with applications to building materials, other insulating materials, and to heat exchanging equipment. Mr. Doolittle.

Courses for Graduates Only

- M. E. 601, 602, 603. Mechanical Engineering Seminar.** 1-1-1
Faculty and graduate student discussions centered around current research problems and advanced engineering theories and developments. Mr. Hanson.
- M. E. 604. Mechanical Engineering Research.** Credits by arrangement
Prerequisites: M. E. 403, 413.
Research and thesis in connection with M. E. 671, 672, 673; M. E. 681, 682, 683; M. E. 651, 652, 653.
- M. E. 611, 612, 613. Advanced Machine Design.** 3-3-3
Prerequisite: M. E. 413.
Continued application of the principles of Mechanics and the Strength of Materials to the design of machine elements, culminating in the design of composite machines. Economic considerations are stressed and an effort is made to develop good judgment and a sense of proportion in the student. Mr. Faïres.

- M. E. 631, 632, 633. Machinery Laboratory. 1-1-1
Prerequisite: M. E. 413.
Experimental work on various phases of design and machine analyses. The work will consist of experiments in machine stress analysis by several methods, vibrations, and lubrication. Messrs. Neale, Whitfield.
- M. E. 635, 636. Mechanics of Machinery. 0-3-3
Prerequisites: M. E. 413, Math. 401.
Advanced study of the Kinematics and Kinetics of Machines, with special emphasis on static and inertia forces. The course includes balancing of machinery, and the complete force analysis of a machine. Mr. Faires.
- M. E. 651, 652, 653. Heating and Air Conditioning Design. 3-3-3
Prerequisites: M. E. 555 or M. E. 383.
The design of heating and air conditioning systems; the preparation of specifications and performance tests on heating and air conditioning equipment. Mr. Knight.
- M. E. 671, 672, 673. Advanced Engineering Thermodynamics. 3-3-3
Prerequisite: M. E. 308.
An intensive study of the fundamental thermodynamic principles and their application to advanced engineering problems. Mr. Doolittle.
- M. E. 681, 682, 683. Advanced Power Plants. 3-3-3
Prerequisite: M. E. 403.
The selection and design of various pieces of heat-power equipment; the interrelation of equipment in various types of power plants and the effects of this equipment on the performance of the plant as a whole. Messrs. Hanson, Lee.

AERONAUTICAL OPTION

- Ae. E. 421, 422, 423. Airplane Design. 3-3-3
Prerequisites: E. M. 422; Concurrent with Ae. E. 431, 432, 433.
Required of seniors in Aero. Option.
A study of the design and construction of airplanes. Work in class and drafting room of a complete airplane design project including preliminary layout, detail design, CAA requirements for design, and stress analysis of the structure as required by the Department of Commerce. Mr. Pinkerton.
- Ae. E. 431, 432, 433. Aerodynamics. 3-3-3
Prerequisites: Math. 401, Ae. E. 310, E. M. 430.
Required of seniors in Aero. Option.
A study of engineering aerodynamics, airplane performance, stability and control; including an introduction to transonic and supersonic aerodynamics. Mr. Pinkerton.
- Ae. E. 441, 442, 443. Aeronautical Laboratory. 1-1-1
Prerequisites: M. E. 309 and M. E. 315. Concurrent with Ae. E. 431, 432, 433.
Required of seniors in Aero. Option.
Wind tunnel testing of airplane components, bluff bodies, airfoils, laminar and turbulent flows. Structural testing of modern airplane parts with special emphasis on CAA load test requirements. A study of modern aircraft engines, hydraulic systems, and instrument design. Mr. Pinkerton.

Courses for Graduates and Advanced Undergraduates

- Ae. E. 565. Aircraft Instruments. 3-0-0
Prerequisite: Ae. E. 310.
A study of modern aircraft instruments including power plant, flight and navigation instruments. Mr. Pinkerton.

Ae. E. 566. Flight Test Techniques. 0-0-3

Prerequisite: Ae. E. 310.

Methods of obtaining aerodynamic data through flight testing, flight test evaluation of airplanes, flight data reduction to standard condition, instrumentation and flight test procedures. Mr. Pinkerton.

Ae. E. 567. Propeller and Rotary Wing Design. 0-3-0

Prerequisite: Ae. E. 310.

A study of the design of aircraft propellers and rotary wing theory and design. Discussions of problems of performance evaluation, control and stability, as applied to rotating wing aircraft. Mr. Pinkerton.

Ae. E. 571, 572, 573. Theory and Design of Aircraft Structures. 3-3-3

Required in Fifth-Year Curriculum in Aero. Option.

Prerequisite: E. M. 422.

The study of design methods for structural components subjected to any given combination of loads. Methods of structural analysis of various structural types used for the major structural items of a modern metal airplane. Study includes: truss and frame analysis; problem of instability; analysis of thin wall structures. Mr. Pinkerton.

Courses for Graduates Only

Ae. E. 631, 632, 633. Advanced Aerodynamics. 3-3-3

Prerequisite: Ae. E. 433.

Required in Fifth-year curriculum in Aero. Option.

Mathematical and theoretical treatment of aerodynamics of non-viscous and viscous fluids. Introduction to conformal transformation and three dimensional flows. Supersonic aerodynamics including critical Mach numbers, shock wave mechanics and supersonic airfoil theory. Mr. Pinkerton.

Ae. E. 635, 636. Hydrodynamics. 0-3-3

Co-requisites: Ae. E. 632, 633.

Resumé of modern theoretical hydrodynamics and hydraulics in connection with aerodynamics. Emphasis is placed on hydrodynamic design of seaplane hulls and the design and testing of models in the various types of towing tanks. Study of stability problems of seaplane hulls and float combinations. Mr. Pinkerton.

Ae. E. 664. Aircraft Applied Loads. 3-0-0

Prerequisite: Ae. E. 433.

The study of external loads applied to the airplane, maneuvering and gust loads, spanwise airload distributions for unswept and swept wings, dynamic flight loads. Mr. Pinkerton.

Ae. E. 665. Flying Qualities. 0-3-0

Prerequisite: Ae. E. 433.

The study of design factors as they affect stick free and stick-fixed and maneuvering stability, lateral controllability and control force determination. Mr. Pinkerton.

DEPARTMENT OF MODERN LANGUAGE

Graduate Faculty

Professor: LAWRENCE EARLE HINKLE.

The courses listed below are designed primarily to assist graduate students in preparing themselves for the use of modern foreign languages in their research and advanced study. Although these courses do not carry graduate language credit, they may be taken as a means of attaining a reading knowledge.

M. L. 411, 412. Introductory Scientific French.

3-3-0 or 0-3-3

Prerequisite: M. L. 201 or equivalent.

A study of scientific French of intermediate difficulty, supplemented with lectures on terminology and other linguistic technique. The needs of students whose interest is that of the acquisition of a reading knowledge of the language, constantly kept in view. Basic technique of translation explained and demonstrated by means of personal conferences.

Mrs. Hall.

M. L. 414, 415. Introductory Scientific German.

3-3-0 or 0-3-3

Prerequisite: M. L. 204 or equivalent.

A study of scientific German of intermediate difficulty supplemented with lectures on terminology and other linguistic technique. The needs of students whose interest is that of the acquisition of a reading knowledge of the language, constantly kept in view. Basic technique of translation explained and demonstrated by means of personal conferences.

Mr. Hinkle.

M. L. 407, 408, 409. Scientific Spanish.

3-3-3

A study of scientific literature appearing in current bulletins, magazines, and technical journals. Students given the opportunity of working a translation project in connection with their subject of major interest. Special attention given to the comprehension of the thought of the article under consideration and its accurate rendition into English. Parallel readings, reports, and conferences.

Mr. Ballenger.

M. L. 501, 502, 503. Advanced Scientific French.

3-3-3

Prerequisite: M. L. 311 or 312 or equivalent.

A study of scientific literature appearing in current bulletins, magazines and technical journals. Students given the opportunity of working a translation project in connection with their subject of major interest. Special attention given to the comprehension of the thought of the article under consideration and its accurate rendition into English. Parallel readings, reports and conferences.

Mr. Hinkle.

M. L. 504, 505, 506. Advanced Scientific German.

3-3-3

Prerequisite: M. L. 314 or 315 or equivalent.

Reading and translations of relatively difficult technical German, supplemented by lectures on terminology, word order, vocabulary analysis and other linguistic technique. Designed to meet the needs of students whose interest in the language is primarily that of reading ability. Choice of reading material adjusted to individual needs; may be taken by students of varying degrees of previous linguistic training.

Mr. Hinkle.

DEPARTMENT OF OCCUPATIONAL INFORMATION AND GUIDANCE

See Education

DEPARTMENT OF PHILOSOPHY AND RELIGION

Although the Department of Philosophy and Religion offers no graduate degrees, the courses listed below may be of interest to graduate students.

Philosophy 400. Foundations of Science.

0-0-3

Nature and validity of knowledge, basic concepts of modern science, scientific method, and the implications of the philosophy of modern science for ethics, social philosophy, and the nature of reality.

Mr. Bredenberg.

Rel. 408. Christian Personality in Its Psychological Aspects.

3 credits

Prerequisite: Six term credits in Religion or related fields.

An analysis of the psychological validity of the principal ethical teachings of the Sermon on the Mount with emphasis on the relationship of religious attitudes and practices to mental and emotional stability and maturity.

Mr. Gardner.

Courses for Graduates and Advanced Undergraduates

Philosophy 505. Social Ethics.

0-0-3

Prerequisite: Six term credits in Philosophy or related fields.

Review of the ethical codes of professional groups, with analysis of the nature, evolution, and significance of moral values in personal and group life.

Messrs. Bredenberg, Middleton.

Rel. 506. Problems of Religion.

3 credits

Prerequisite: Six term credits in Religion or related fields.

Religious verities in an age of science and problems of the church in modern times.

Mr. Gardner.

Philosophy 507. Ethical Problems of Adolescence.

3 credits

Prerequisite: Six term credits in Philosophy or related fields.

Typical adjustment problems of modern youth, with special consideration to the determination of standards of behavior and the sources of motivation for right conduct.

Mr. Hicks.

DEPARTMENT OF PHYSICS

Graduate Faculty

Professors: CLIFFORD KEITH BECK, Head, FOREST WESLEY LANCASTER, JEFFERSON SULLIVAN MEARES, ARTHUR CLAYTON MENIUS, RAYMOND LEROY MURRAY, RUFUS HUMMER SNYDER, NEWTON UNDERWOOD.

Associate Professor: ELMA LANTERMAN, ARTHUR W. WALTNER.

Visiting Lecturer: JOSEF OSKAR NYSTROM.

The Master of Science in Engineering Physics is intended primarily for students having an undergraduate degree in some field of engineering who wish to develop, by an additional year of study, a more intimate acquaintance with the contents and methods of physics. The course is intended to develop men who are sufficiently grounded in the engineering approach to

solution of problems, and sufficiently versed in the subject matter of physics that they are able at once to take their places in scientific and engineering research and developmental groups where practical applications of physics are required.

In some cases, students with undergraduate records in "arts and science" are interested in a graduate degree in Engineering Physics. Here, it is necessary to develop a foundation knowledge of basic engineering as a prerequisite to the graduate program.

The Prerequisite Courses are:	The Requisite Courses are: Credits
Differential Equations	Phys. 601, 602, 603—Advanced
Sophomore Physics	General Physics 9
Three Additional Quarter Courses	Phys. 690—Thesis 6
Fluid Mechanics	Phys. 670—Seminar 3
Thermodynamics	Mathematics 9
Three Additional Quarter Courses	Phys. 611—Quantum Mechanics 3
in Engineering	*Electives 15
Physics 407, 410.	—
	45

* At least 12 of these elective credits must be selected, with the assistance of an advisory committee, as a coherent sequence in engineering or in mathematics and engineering.

The Master of Science in Nuclear Engineering

This is a pioneering program of study developed at North Carolina State College to prepare men to enter the rapidly developing field of applied nuclear processes. In actual practice, as the applications of nuclear processes have developed, portions of the knowledge and techniques commonly found in many different orthodox fields of engineering are involved. One person would find it impossible to become an expert in all of these. Yet, in the application of all these orthodox skills to nuclear processes, a considerable body of knowledge and techniques arising from and peculiar to nuclear phenomena are involved.

The plan of the Nuclear Engineering Curriculum (at the Master's level), therefore, includes three groups of courses:

1. Basic science: Mathematics, Chemistry, Physics.
2. Nuclear Technology: Reactor Design, Reactor Theory, Radiation Protection and Precautions, etc.
3. Elective courses chosen to form a related sequence in a chosen field of particular interest.

The chief fields of interest and application to nuclear engineers are:

- a. Mechanical-Metallurgical.
- b. Heat Transfer-Power Generation.
- c. Chemistry and Chemical Engineering.
- d. Instrumentation and Control.
- e. Theoretical: Mathematics; Advanced Reactor Theory
- f. Life Sciences; Bio-Chemistry and Physics.

The Prerequisite Courses are:

Differential Equations

Sophomore Physics

Three Additional Quarter Courses
in Physics

Fluid Mechanics

Thermodynamics

Three Additional Courses in Engi-
neering

Physics 410

Physics 411

Physics 418

Physics 419

The Requisite Courses are: Credits

Physics 670—Seminar 3

Physics 690—Thesis 6

Mathematics 6

Any two of the following
courses: 6

Phys. 610, Advanced Nuclear
Physics

Phys. 618, Advanced Radia-
tion Hazard and Protection

Phys. 619, Reactor Design

Phys. 630, Advanced Reactor
Theory

*Technical Electives 24

45

*Must include a sequence of at least 12 credits in a minor field.

Doctor of Philosophy Degree

Adequate instructional and research facilities are available to afford opportunity for training to the doctoral level in either Engineering Physics or Nuclear Engineering. Inasmuch as both of these courses are slanted toward a practical or "applied" emphasis, it is usual for the doctorate candidate to develop a strong minor interest in some related field of engineering, along with advanced technical and theoretical courses in physics, mathematics and Nuclear Engineering.

Instruction and Research Facilities

The instructional courses in the Physics Department are developed around two major fields of interest: (1) Nuclear Physics and Nuclear Engineering, and (2) Solid State Physics. Adequate coverage to development of minor interest is available in infrared, ultrasonics, electronics, thermodynamics, spectroscopy, etc.

The above named fields are also the principal in which adequate facilities for research are available. Mention should also be made of the exceptionally well-equipped High Voltage Laboratory of the Electrical Engineering Department which is available to Physics students as well.

The principal research tool of the Department is a 10,000 watt, homogeneous type nuclear reactor—The Raleigh Research Reactor. For three years a major effort of the staff has been devoted to the design and construction of this reactor. It will be placed in operation early in 1953. This unit will not only constitute a unique and powerful tool in the study of many problems of physics, and will itself present research challenges of intrinsic value, but the problems which will be attracted to it, and thus be brought within the purview of Physics students, will be as diverse as the fields of science itself.

In addition to the facilities mentioned above, other items available to Physics students for research investigations are:

X-ray Diffraction Equipment, for multicrystal and single crystal studies, and with photographic or automatic electronic recording.

Complete metallagraphic laboratories with microscopes, cameras, etc.

Recording infrared spectrograph (Perkin-Elmer).

High dispersion optical spectrograph (Hilger).

Optical spectrograph for ultra violet (Hilger).

Precision polarimeter (Bellingham Stanly).

Electron-Microscope (RCA Universal).

Deuteron-Deuteron neutron source (R. F. ionization).

Mass Spectrograph (Consolidated).

A considerable number of the research projects in Nuclear Engineering and in Engineering Physics are jointly directed and performed with staff members of other Departments. Hence, the research facilities available to these students are much larger than those possessed by the Physics Department alone.

Courses for Advanced Undergraduates

Phys. 401, 402, 403. Intermediate Physics II.

4-4-4

Prerequisites: Phys. 203, Math. 401.

Electricity, magnetism, and optics on an intermediate level. Intermediate Physics II, together with Intermediate Physics I, constitutes an integrated study of classical physics at the next level above general sophomores physics. Lectures, problems, recitations, and one laboratory each week.

Mr. Underwood.

Phys. 407. Introduction to Modern Physics.

3 or 3 or 3

Prerequisites: Phys. 203, Math. 303.

A brief survey of the important developments in atomic and nuclear physics. Topics covered include: atomic and molecular structure, determination of the mass and charge of ions, origin of spectra, ion accelerators, nuclear reactions, and cosmic rays. Particular attention is paid to the practical applications of these developments.

Staff.

Phys. 410. Nuclear Physics I.

4 or 4-0

Prerequisite: Phys. 407.

An introductory treatment of the properties of nuclear particles and their interactions with matter. Consideration is given to natural and artificial radioactivity, nuclear reactions, fission, and the structure of simple nuclei. A three-hour laboratory is included.

Messrs. Beck, Waltner.

Phys. 411. Nuclear Instrumentation.

3-0 or 3

Prerequisite: Phys. 410.

This is a laboratory course designed to acquaint students with the principles of operation of apparatus used for measuring ionizing radiations. One lecture and two laboratory periods per week.

Mr. Underwood.

Phys. 418. Radiation Hazard and Protection.

0-3-0

Prerequisite: Phys. 410.

A survey of the precautionary methods used in radioactive work. Safe limits of exposure and tolerance dosage of alpha, beta, gamma, and neutron radiation; monitoring procedures; calculation of exposure doses; and general protective methods are discussed.

Mr. Underwood.

Phys. 419. Introduction to Nuclear Engineering.

0-3-0

Prerequisite: Phys. 410.

A survey of the engineering applications of nuclear energy. The principles and practices of isotope separation, production of plutonium, and nuclear reactor operation are studied along with the peace-time uses of products and by-products of nuclear reactors. Major engineering problems involved in each phase of the study are defined and the special methods of approach indicated.

Mr. Murray.

Courses for Graduates and Advanced Undergraduates

Phys. 510. Nuclear Physics II.

0-4-0

Prerequisite: Phys. 410.

A continuation of physics 410 with particular emphasis on neutron physics, nuclear energy levels, meson theory, nuclear resonance, atomic and molecular magnetism, and cosmic radiation. A three-hour laboratory is included.

Mr. Waltner.

Phys. 520. Physical Technology in Radioactivity.

0-4 or 4

Prerequisite: Phys. 410.

Emphasis in this course is on laboratory practices in detecting, handling, and quantitatively measuring radioactive samples. The preparation of samples for radioactivity measurements and the calculation methods used in analyzing such data are summarized. At least three hours of laboratory practice per week.

Miss Lanterman, Mr. Lynn.

Phys. 526. Ionization Phenomena and Electron Optics.

0-0-3

Prerequisites: Phys. 403, Phys. 410.

Methods of producing ions, and the interaction of ions with electric and magnetic fields are discussed, together with a brief survey of the present status of electron optics.

Mr. Murray.

Phys. 530. Elementary Nuclear Reactor Theory.

0-0-3

Prerequisites: Phys. 410; Math. 511 or Math. 532.

A lecture course in the principles of chain reactors. Slowing down of neutrons, neutron diffusion equations, space distribution of neutrons, conditions for criticality, reactor dimensions for simple geometries, elementary group theories, and time dependent reactor behavior.

Mr. Murray.

Phys. 531, 532, 533. Advanced Physical Measurements.

2-2-2

Prerequisites: Phys. 203, Math. 303.

Covers the technique and theory of advanced experiments in mechanics, heat, sound, light, and electricity. The treatment and interpretation of data are stressed.

Graduate Staff.

Phys. 544. Vibration and Wave Motion.

0-3-0

Prerequisites: Phys. 203, Math. 401.

The dynamics of vibratory and oscillatory motion. Analogies in mechanical, electrical and acoustical vibrating systems. Analysis of wave motion and propagation in different media.

Mr. Lancaster.

Phys. 545. Applied Acoustics.

0-0-3

Prerequisite: Phys. 544.

The dynamical theory of sound. Sources of sound, measurement of sound intensity, measurement of frequency, acoustical impedance and transmission of sound, sound filters and resonators, acoustics of speech and hearing, reception and reproduction of sound, acoustics of buildings.

Mr. Lancaster.

Phys. 551. Introduction to X-Rays.

3-0-0

Prerequisites: Phys. 203, Math. 303.

Topics include detection of defects in welds and castings, crystal and powder diffraction, and fiber and particle size measurement. Enough theory

is included to provide intelligent guidance in the applications of X-rays, but the main emphasis is on laboratory practice. Miss Lanterman.

Phys. 552. X-Ray Theory and Optics. 0-3-0

Prerequisites: Phys. 203, Math. 303; Phys. 551 recommended.

Emphasis is placed upon the origin of X-rays and the optical principles underlying the diffraction of X-rays. Methods of determining crystal structure by means of X-ray diffraction are considered. The demonstration of X-ray equipment with occasional manipulation by the student is a part of the course. Miss Lanterman.

Phys. 553. Structure of Solids; Crystallography. 0-0-3

Prerequisites: Phys. 203, Math. 303; Phys. 552 recommended.

Elementary consideration of amorphous and crystalline solids, metals, conductors, non-conductors, and semi-conductors. Some optical crystallography is included. Miss Lanterman.

Courses for Graduates Only

Phys. 601, 602, 603. Advanced General Physics. 3-3-3

Prerequisites: Phys. 402, Math. 511.

Mathematical and theoretical approach to relationships between the various branches of physics, with applications to mechanical, electrical, optical, thermal, and vibratory problems. Generalization of underlying physical principles. Mr. Menius.

Phys. 610. Advanced Nuclear Physics. 0-0-3

Prerequisite: Phys. 410; Phys. 611 is recommended.

Current hypothesis of nuclear structure and reactions, including fission, theories of alpha emission, deuteron binding, neutron-proton scattering, the compound nucleus, and beta-decay. The use of neutrons in present day nuclear research is emphasized. Mr. Murray.

Phys. 611, 612, 613. Quantum Mechanics. 3-3-3

Prerequisites: Phys. 407; Math. 532.

The theory of quantum mechanics with applications to atomic and molecular structure, scattering phenomena, and the interaction of radiation with matter. Mr. Menius.

Phys. 618. Advanced Radiation Hazard and Protection. 0-0-3

Prerequisite: Phys. 418.

Further consideration of safe practices in handling radioactive materials. Calculation of necessary shielding conditions for various geometries and combinations of radiations. Mr. Underwood.

Phys. 619. Reactor Design. 3-0-0

Prerequisite: Phys. 530.

Engineering design of typical reactors of various kinds: homogeneous, heterogeneous, stationary power, power-breeder, experimental, aircraft propulsion. The problems involved in the choice of materials of construction, medium for heat exchange, and reactor control are considered. Principles of heat transfer are developed as needed. Mr. Murray.

- Phys. 621. Kinetic Theory of Gases.** 3-0-0
Prerequisites: Phys. 203; Math. 511.
The theory of molecular motion, including the velocity and density distribution functions, the phenomena of viscosity, heat conduction and diffusion; equations of state; fluctuations. Mr. Murray.
- Phys. 622, 623. Statistical Mechanics.** 0-3-3
Prerequisites: Phys. 203, Math. 511; Phys. 621 is recommended.
A treatment of statistical mechanics from both the quantum and classical point of view. Development of theories from the thermodynamical standpoint and their practical application. Mr. Murray.
- Phys. 625. High Vacuum Technique.** 0-0-3
Prerequisite: Phys. 621.
A course in the design and maintenance of vacuum systems. Consideration is given to the calculation of pumping speeds, detection of leaks, absolute and relative measurements of pressure. Mr. Murray.
- Phys. 630. Advanced Reactor Theory.** 3-0-0
Prerequisite: Phys. 530.
The mathematical and physical description of neutron motion and reactor behavior. The two- and multi-group methods of calculating critical dimensions and neutron flux; determination by the use of transport theory of the limitations of diffusion theory; resonance capture in uranium and thermal utilization of heterogeneous reactors. Mr. Murray.
- Phys. 631, 632. Atomic Spectra.** 3-3-0
Prerequisite: Phys. 403. Co-requisites: Phys. 611, Math. 532.
Atomic models and coupling schemes. Multiple series, Zeeman, Paschen-Back, and Stark effects. Hyperfine structure and complex spectra. Messrs. Menius, Lancaster.
- Phys. 633. Molecular Spectra.** 0-0-3
Prerequisite: Phys. 403. Co-requisites: Phys. 611, Math. 532.
Spectra of polyatomic molecules. Infrared and Raman Spectroscopy, with applications to various chemical problems. Mr. Lancaster.
- Phys. 661, 662, 663. The Solid State.** 3-3-3
Prerequisite: Phys. 553.
The electron theory of conduction, electrical and thermal conduction in solids, and surface phenomena, with applications to physical behavior and usage of solids. (Offered in 1952-53 and alternate years.) Mr. Nystrom.
- Phys. 670. Seminar.** 1 to 3
Literature surveys and oral presentation of papers on special topics.
- Phys. 690. Research.** Credits by arrangement
Graduate students sufficiently prepared may undertake research in some particular field of Physics. Graduate Staff.

PLANT PATHOLOGY

A UNIT OF THE DIVISION OF BIOLOGICAL SCIENCES

Graduate Faculty

Professors: JAMES HERBERT JENSEN, Head, JOSEPH LEWIS ALLISON, CARLYLE NEWTON CLAYTON, DON EDWIN ELLIS, SAMUEL GEORGE LEHMAN, CHARLES JOSEPH NUSBAUM.

Associate Professors: LOWELL WENDELL NIELSON.

Assistant Professors: TEDDY THEODORE HEBERT, ARTHUR KELMAN, GEORGE BLANCHARD LUCAS.

The Master of Science and Doctor of Philosophy degrees are offered in Plant Pathology.

Excellent library, laboratory, greenhouse, and office facilities are available for graduate study in plant pathology. Special equipment for temperature control, photographic and microscopic work are available. The state's wide range of soil types and climatic areas make possible the commercial production of a variety of field, vegetable, fruit and ornamental crops. Especially favorable opportunities exist for training in diseases caused by nematodes, viruses, fungi and bacteria. Plot work and field space is available at some fourteen or more permanent test farms located throughout the state. Student participation in the Plant Disease Clinic provides opportunities for experience in the diagnosis of all types of plant diseases.

Many opportunities for employment in research, extension and teaching are available to men with M.S. or Ph.D. degrees in plant pathology. Openings are available for qualified men in plant pathology research in the United States Department of Agriculture, State Experiment Stations and in industry. Unusual opportunities exist in foreign service through international and federal organizations as well as commercial production enterprises. The rapid development of agricultural chemicals for disease control offer numerous opportunities in both research, promotion and service activities.

Courses for Advanced Undergraduates and Graduate Students

Pl. Path. 501. Research Methods in Plant Pathology. 5-0-0

Prerequisites: Plant Pathology 315 and permission of the instructor.

Introduction to research techniques and practices in the operation of research equipment used in laboratories and greenhouses for investigating diseases caused by bacteria, fungi, nematodes, viruses and physiogenic factors. Exercises are directed also toward procedures involved in appraising plant pathology research problems, reviewing literature and preparing a manuscript. Mr. Nielsen.

Pl. Path. 515. Diseases of Field Crops. 4-0-0

Prerequisite: Plant Pathology 315.

An advanced study of the more important diseases of field crops such as cotton, corn, tobacco, soybean, alfalfa, clover, grasses and small grains with major emphasis on identification, cause and control. Mr. Lucas.

- Pl. Path. 516. Diseases of Fruit Crops.** 0-3-0
 Prerequisite: Plant Pathology 315.
 Study of causes, symptoms, epiphytology and principles of control of major diseases of pome, stone, nut, and berry crops. Mr. Clayton.
- Pl. Path. 517. Diseases of Vegetable Crops.** 0-3-0
 Prerequisite: Plant Pathology 315.
 Advanced study of the nature, cause and control of the more important diseases of vegetable crops. Mr. Ellis.
- Pl. Path. 601. Phytopathology.** 0-5-0
 Prerequisites: Plant Pathology 315 and permission of the instructor.
 Fundamental principles of the etiology, epiphytology and control of plant diseases. Mr. Nusbaum.
- Pl. Path. 615. Plant Pathology Research.** Credits by arrangement
 Prerequisite: Graduate standing and permission of instructor.
 Research on specific problems in Plant Pathology including the thesis problem. A maximum of nine credits is allowed toward the Master's degree, and any number toward the Doctorate. Staff.
- Pl. Path. 625. Plant Pathology Seminar.** 1-1-0
 Prerequisite: Graduate standing in Plant Pathology.
 Discussion of phytopathological topics.
 A maximum of three credits is allowed toward the Master's degree, but any number toward the Doctorate. Staff.

DEPARTMENT OF POULTRY

Graduate Faculty

Professors: ROY STYRING DEARSTYNE, Head, BENJAMIN FRANKLIN COX,
 EDWARD WALKER GLAZENER.

Associate Professors: JOSEPH WHEELER KELLY.

Assistant Professor: FREEMAN WALDO COOK.

The M.Sc. degree is offered in Poultry Science with major studies in genetics, nutrition, veterinary technology, histology, and hematology. Students expecting to begin graduate study must have the equivalent of an undergraduate major in poultry, and a background of undergraduate study in the biological sciences is desirable. Fundamental work in zoology, chemistry, biochemistry, bacteriology, statistics, and fields that relate directly to the major interest and thesis problem of the graduate student are required as a part of the program for the M.Sc. degree.

Excellent facilities are now available for graduate study in the department. A new three-story Poultry Science Building has been completed with offices, library, bird rooms, and laboratories for graduate training. In addition to the laboratory building, research plants in both chickens and turkeys are available. These plants, with two branch farms in the western and eastern part of the state, offer opportunity for population study in genetics and feeding trials in nutrition.

To offer wider scope to the regular programs of work, cooperative projects are underway with the U.S.D.A. in genetics and pathology.



Recently Constructed Poultry Research Plant.

Many opportunities exist in educational and commercial fields for poultry majors with advanced degrees. The larger feed manufacturers, hatcherymen, and commercial breeders are particularly demanding men with advanced training. The supply of trained men is limited and starting salaries are adequate.

Courses for Advanced Undergraduates

Poul. 401, 402. Poultry Diseases. 0-4-4

Prerequisites: Poul. 101, Bot. 412. Poul. 401 prerequisite to Poul. 402.

Required of majors in Poultry Science; elective for others.

The prevention, control, and treatment of the diseases of poultry.

Mr. Cox.

Poul. 412. Commercial Poultry Plant Management. 0-0-3

Prerequisites: Poul. 101, 303, 520, 521.

Required of majors in Poultry Science; elective for others.

Development and organization of plans for the building, operation and maintenance of a commercial poultry plant. Problem.

Mr. Kelly.

Poul. 423. Poultry Seminar. One credit per term

Prerequisite: Junior and senior courses in Poultry Science.

Required of seniors in Poultry Science.

Topics and problems relating to Poultry Science and Poultry Industry assigned for report and discussion. Three terms.

Staff.

Poul. 520. Poultry Breeding. 0-4-0

Prerequisites: Poul. 101, Gen. 411.

Required of majors in Poultry Science; elective for others.

Application of genetic principles to poultry breeding, considering physical traits and physiological characteristics—feather patterns, egg production, hatchability, growth, body conformation, and utility. Laboratory problems and analysis of progeny performance records.

Mr. Glazener.

Poul. 521. Poultry Nutrition. 0-4-0

Prerequisites: Zool. 101, Chem. 203.

Required of majors in Poultry Science; elective for others.

Protein, vitamin and mineral requirements for growth, egg production and reproduction. Methods of feeding and compounding poultry mashes.

Mr. Kelly.

Poul. 530. Poultry Immunology. 0-0-3

Prerequisites: Poul. 401, 402; Bot. 412.

Elective for advanced students. The fundamentals of immunization and sero-diagnosis in the prevention and control of infectious diseases of poultry.

Mr. Cox.

Courses for Graduates Only

Poul. 601. Advanced Poultry Genetics. 3-0-0

Prerequisite: Graduate standing in Poultry Science.

Study of lethals, skeletal and feather variations. Linkage and chromosome mapping of the fowl. Theory and contemporary ideas concerning genetics of egg and meat production.

Mr. Glazener.

Poul. 602. Advanced Poultry Nutrition. 3 or 3 or 3

Prerequisite: Graduate standing in Poultry Science.

Selected problems involving experimental methods employed to produce nutritional deficiencies in chickens and turkeys. Interpretation and presentation of data collected.

Mr. Kelly.

- Poul. 603. Poultry Histology.** 5 or 5 or 5
 Prerequisite: Graduate standing in Poultry Science.
 Poultry tissues and their preparation. Study and interpretation of the microscopic anatomy of the normal tissues prepared by the student. Principles of histology. Mr. Cook.
- Poul. 604. Poultry Histopathology.** 5 or 5 or 5
 Prerequisites: Graduate standing in Poultry Science. Poul. 603.
 Study and interpretation of the microscopic anatomy of the diseased tissues prepared by the student. Principles of pathology. Mr. Cook.
- Poul. 605. Poultry Hematology.** 5 or 5 or 5
 Prerequisites: Graduate standing in poultry science. Poul. 603, 604.
 Histology and histopathology of the blood forming tissues. Morphology of the normal and pathologic blood cells; supravital and fixed smear techniques. Clinical methods and instruments. Principles of hematology. Mr. Cook.
- Poul. 611. Poultry Research.** Credits by arrangement
 Prerequisite: Graduate standing in Poultry Science.
 Appraisal of present research, critical study of some particular problem involving original investigation. Problems in poultry breeding, nutrition, diseases, histology, histopathology or hematology.
 A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs. Staff.
- Poul. 614. Seminar.** Credits by arrangement
 Prerequisite: Graduate standing in Poultry Science.
 Required of graduate students majoring in Poultry Science.
 A maximum of three credits is allowed toward the Master's degree, but any number toward the Doctorate. Staff.

DEPARTMENT OF PSYCHOLOGY

Graduate Faculty

Professors: DANNIE JOSEPH MOFFIE, Head. KEY LEE BARKLEY.

Associate Professors: HAROLD MAXWELL CORTER, WILLIAM CARL WESTBERG.*

Assistant Professor: PAUL J. RUST.

Visiting Professor: WILLIAM MCGEHEE.

The Department of Psychology at North Carolina State College offers specialized instruction in Industrial Psychology at the Master of Science Degree level. Services and research are in the applied areas with major emphasis in Industrial Psychology. Graduate students are encouraged to take courses in experimental, theoretical, clinical and personnel psychology in the Psychology Department at Chapel Hill to broaden their training in basic psychology.

Thirty quarter hours in psychology or the equivalent of an undergraduate major in psychology are necessary for admission to graduate study in psychology. The Miller Analogies Test and Graduate Record Examination scores must also be submitted. These scores will be used by the Department as supplementary data for admission.

*Resigned September, 1952

The Department offers a number of research assistantships each year. These assistantships pay \$600, \$1,200, or \$1,500 for one academic year (9 months). Students holding such assistantships are assigned to research projects or other departmental activities and are required to work approximately 15 hours per week. Most of these assistantships are provided by contract research with outside agencies.

In cooperation with the North Carolina Highway Safety Division, the Department is investigating the relationship between the visual skills of drivers and their highway accidents. The North Carolina State Optometric Society has contracted with the Department to conduct basic and applied research in determining the relationship of visual skills to success on the job, to academic success, to personality structure, and to physical comfort. The McLean Trucking Company is sponsoring an inquiry into the relationship between psychological data and the frequency of accidents involving its drivers.

Within the last five years the field of psychology has become professionalized in three areas, (1) Clinical Psychology, (2) Industrial Psychology, and (3) Guidance and Counseling Psychology. To become prepared to practice any one of these areas of psychology, one is required to do graduate work in psychology in much the same way as in other professions such as medicine. In addition to academic training, many graduate schools are requiring students to complete a certain amount of internship work.

Upon completion of a Master's degree in Industrial Psychology, a student may find employment in industry doing research in personnel, training or safety. Very often he may become the Director of Personnel and Safety or may be employed as the director of either of these two activities. In large industrial organizations where a man with a Ph.D. degree in Industrial Psychology is already employed, a student with a Master's degree may be a member of the psychological team.

Many opportunities exist for graduates in Industrial Psychology in state and government offices. The Armed Services are needing and will continue to need trained industrial psychologists in their research programs.

Courses for Advanced Undergraduates

Psychol. 439. Psychology of Industrial Training.

0-3-0

Prerequisites: Psychology 200, and three additional hours in Psychology.

A study of the factors involved in training an employee to perform a certain task requiring skills that he does not already possess. Consideration of effective methods for training inspectors, apprentices, and supervisors.

Mr. Solem.

Psychol. 440. Interviewing and Counseling in Industry.

0-0-3

Prerequisites: Psychology 200, and 3 additional hours in Psychology.

A study of the principles of interviewing and counseling; trends in methods and techniques including non-directive and direct techniques. Course is designed for the undergraduate student and application made to industry.

Mr. Solem.

Psychol. 476. Psychology of Adolescence.

0-3 or 3

Prerequisite: Psychology 304.

Mental growth, social development, and interests of adolescent boys and girls.

Messrs. Johnson, Barkley.

Psychol. 490. Social Psychology.

0-0-3

Prerequisite: Psychology 200.

Social applications of psychology: social stimulation, response, and attitudes.

Mr. Barkley.

Courses for Advanced Undergraduates and Graduates

Psychol. 501. Intermediate Applied Experimental Psychology. 0-3-0
Prerequisite: Six hours in Psychology.

Experimental study of problems in the major areas of general and theoretical psychology which have special significance in educational, industrial, and applied social psychology. Emphasis will be placed upon description of problems, study of methods, design of experiments, and procedures for the analysis and presentation of data. One lecture and two laboratory periods per week.
Mr. Barkley.

Psychol. 504. Advanced Educational Psychology. 0-0-3
Prerequisite: Psychol. 304.

An advanced course giving a critical appraisal and a consideration of the practical applications for vocational education of modern psychological findings.
Messrs. Barkley, Johnson.

Psychol. 511. Advanced Social Psychology. 0-0-3
Prerequisites: Psychol. 200, 490.

A study of social relationships and their psychological bases; emphasis on those aspects of behavior determined by personal interactions; work will involve analysis of representative research studies, and doing individual projects in industrial and rural areas.
Mr. Barkley.

Psychol. 530. Abnormal Psychology. 0-0-3
Prerequisites: Psychology 200, 302.

A study of the causes, symptomatic behavior, and treatment of the major personality disturbances, emphasis also placed on preventive mental hygiene methods.
Mr. Corter.

Psychol. 535. Tests and Measurements. 0-0-3
Prerequisite: Psychology 304.

A study of available tests, with emphasis on proper selection and use of testing instruments; also a study of statistical procedures needed in the proper use of tests, including measures of central tendency, variability and correlation.
Messrs. Moffie, Johnson.

Psychol. 550. Mental Hygiene in Teaching. 0-3-0
Prerequisite: Six hours in Psychology.

A survey of mental hygiene principles applicable to teachers and pupils; practical problems in prevention and treatment of psychological problems in schools; case studies and research.
Mr. Corter.

Psychol. 560. Psychometric Methods I. 0-3-0
Prerequisite: Six hours in Psychology.

Analyzes the steps necessary for the development of tests, including job analysis, test development of different types of items, item analysis, establishment of norms and determination of reliability. Emphasis placed on construction of mechanical tests with application to industry. Students will be given opportunity for construction of tests.
Mr. Moffie.



Measurement of Physiological Aspects of Emotion Through
Use of a Pneumograph.

- Psychol. 561. Psychometric Methods II.** 0-0-3
 Prerequisite: Psychol. 560.
 Emphasis placed on criterion analysis, rating scale methods, validation procedures. Attention will be directed to the validation of tests constructed in Psychology 560. Mr. Moffie.
- Psychol. 564. Psychological Aspects of Occupational Vision.** 0-0-3
 Prerequisite: Six hours in Psychology.
 Consideration given to the importance of vision in school, business, and industry; the relation between vision and job success. A survey of professional visual services and commercial visual screening instruments. Study of research and research methodology in occupational vision. Mr. Kelley.
- Psychol. 570. Psychodiagnostic Techniques I.** 3-0-0
 Prerequisites: Six hours in Psychology.
 An introduction to individual intelligence testing, theoretical background of intelligence testing, clinical introduction to intelligence testing, case studies and research. Mr. Corter.
- Psychol. 571. Psychodiagnostic Techniques II.** 0-3-0
 Prerequisite: Psychology 570 or equivalent.
 A practicum in individual adult intelligence testing with emphasis on the Wechsler-Bellevue, other performance tests of intelligence, report writing, and case studies. Mr. Corter.
- Psychol. 572. Psychodiagnostic Techniques III.** 0-0-3
 Prerequisite: Nine hours in Psychology, including Psychology 570 or equivalent.
 A practicum in individual intelligence testing of infants, children and adults with emphasis on the Stanford-Binet, other tests, report writing, case studies, and consultation with teachers. Mr. Corter.
- Psychol. 576. Advanced Adolescent Psychology.** 0-0-3
 Prerequisites: Psychology 304 and 476.
 An advanced course in psychology of adolescence in which the student considers the original works of leaders in this field, thus, laying the foundation for a critical appreciation of the new studies that are constantly appearing. Mr. Barkley.
- Psychol. 578. Individual Differences.** 3-0-0
 Prerequisite: Six hours in Psychology.
 Nature, extent, and practical implications of individual differences and individual variation. Mr. Barkley.

Courses for Graduates Only

- Psychol. 604. Applied Experimental Psychology.** 0-0-3
 Prerequisite: Twelve hours in Psychology.
 Experimental analysis of problems of sensation, perception, learning, thinking, emotions, fatigue, and neuro-muscular reaction. Emphasis upon methods of experimental control, design of experimental apparatus, and accuracy of reports as these are related to laboratory investigations in the fields of applied psychology. Mr. Barkley.

- Psychol. 605. Advanced Industrial Interviewing and Counseling.** 0-0-3
 Prerequisite: Twelve hours in Psychology.
 Interviewing, counseling, and psychotherapy; trends in methods and techniques, including non-directive or client-centered therapy. Application made to industry. Mr. Moffie.
- Psychol. 607. Advanced Industrial Psychology I.** 3-0-0
 Prerequisite: Twelve hours in Psychology.
 Discussion, analysis and evaluation of psychological problems in industry; selection and placement of the worker. Emphasis on current research and study of psychological programs operating in different industries. Messrs. Moffie, McGehee.
- Psychol. 608. Advanced Industrial Psychology II.** 0-3-0
 Prerequisite: Twelve hours in Psychology.
 Discussion, analysis and evaluation of psychological problems in industry; training, morale, attitudes, fatigue, accidents, and maladjusted workers. Emphasis on current research and study of psychological programs operating in different industries. Messrs. Moffie, McGehee.
- Psychol. 609. Psychological Clinic Practicum.** 0-0-3
 Prerequisite: Twelve hours in Psychology.
 Clinical participation in interviewing, counseling, psychotherapy and administration of psychological tests. Practicum to be concerned with college students, adults and children. Mr. Corter.
- Psychol. 610. Applied Implications of Theories of Learning.** 0-3-0
 Prerequisite: Twelve hours in Psychology.
 A study of theories of learning with emphasis upon applications of the principles of learning in industrial and school situations. Mr. Barkley.
- Psychol. 612. Research.** Credits by arrangement
 A maximum of nine credits will be allowed toward the master's degree. Graduate Staff.
- Psychol. 616. Seminar in Industrial Psychology.** 0-0-3
 Prerequisite: Twelve hours in Psychology.
 Scientific articles, analysis of experimental designs in industrial psychology, and study of special problems of interest to graduate students in Industrial Psychology. Staff.

DEPARTMENT OF RURAL SOCIOLOGY

Graduate Faculty

Professor: CHARLES HORACE HAMILTON.

Associate Professor: SELZ CABOT MAYO.

The Master of Science and the Doctor of Philosophy degrees are offered by the Department of Rural Sociology.

Graduate students studying for the Ph.D. degree are required to take about 30 term hours in the Department of Sociology at the University of North Carolina, Chapel Hill, N. C.

The physical and educational resources of this department include: (1) A departmental library of bulletins, monographs, and other materials. Several thousand items, accumulated over a period of 30 years, are available in

indexed files for the use of graduate students; (2) laboratory equipment includes calculating machines, drawing table, and instruments, chart making materials, cameras, typewriters, and statistical aids; (3) automobiles are available for field surveys; and (4) IBM tabulating equipment, operated by the Department of Experimental Statistics, is available to graduate students in rural sociology.

Providing, as it does, training in a number of social sciences, rural sociology at State College prepares the graduate student for a wide variety of positions. Men and women with graduate degrees in rural sociology have opportunities for careers in college teaching, sociological research, social statistics, social work, administration of social organizations and governmental agencies, agricultural journalism, and in those branches of the government's foreign service relating to agriculture and the development of backward agricultural areas of the world.

Institutions offering employment to graduates are: Land Grant Colleges, Agricultural Experiment Stations, and Extension Services; United States Department of Agriculture; United States Department of State; Federal Security Agency; State Departments of Welfare, Health, and Education; farm journals and newspapers; voluntary social agencies, such as Red Cross, Community Chest, Boy Scouts, and National Tuberculosis Association.

Each year two or more outstanding graduate students are awarded research assistantships, usually involving working on a research project one half time. Cooperative research work with various governmental agencies frequently provide part-time employment for graduate students.

Courses for Advanced Undergraduates

Rural Soc. 411. Rural Population Problems. 0-3-0

The number and distribution in relation to natural resources; physical and demographic characteristics; marriage rates; natural increase; migration; morbidity; mortality; occupations; rural-urban comparisons trends; and national policies.

Mr. Mayo.

Rural Soc. 412. Rural Family Living. 0-3-0

Theories, problems, and surveys of rural standards and conditions of living. Forces and programs affecting present day standards.

Mr. Hamilton.

Rural Soc. 441. Rural Social Pathology. 3-0-0

Problems of the individual arising out of the failure to adjust in society: such as juvenile delinquency, crime and mental disorders. Problems of family and community disorganization; and economic maladjustments.

Mr. Mayo.

Courses for Graduates and Advanced Undergraduates

Rural Soc. 513. Community Organization. 0-0-3

Community Organization in North Carolina and other states; structure and size; institutions and service agencies; disorganization; techniques and methods of organization; leadership and the relation of organizations to State and National agencies.

Mr. Mayo.

Rural Soc. 521. Rural Social Psychology. 0-0-3

Characteristic mental traits and attitudes of rural people in relation to social organization and social change.

Mr. Lowry.

Rural Soc. 522. Social Aspects of Land Tenure. 0-0-3

Character and history of different types of land tenure; origins and growth of farm tenancy in the United States; social correlatives of land tenure; landlord-tenant relationships; farm leases; problem of ownership; farm mortgages; reform programs.

Mr. Green.

Rural Soc. 532. Social Security of Rural People. 0-3-0

Analysis of the major fields of security and insecurity in American rural life. Problems of insecurity are studied with respect to extent, causes, effects, and methods of dealing with them. Special attention is given to the functioning of Federal-State Social Security in rural society and recent developments are reviewed.

Mr. Mayo.

Rural Soc. 534. (Same as Hist. 534.) Farmer's Movements. 0-0-3

The origin, growth, and present status of such national farmers' organizations and movements as the Grange, the Farmers' Alliance, the Populist Revolt, the Farmers' Union, the Farm Bureau, the Society of Equity, the Non-partisan League and co-operative marketing.

Mr. Noblin.

Rural Soc. 551, 552. Statistical Analysis of Social Data. 3-3-0

Prerequisite: Stat. 512.

Applications of statistical theory to special problems in sociological research.

Mr. Hamilton.

Courses for Graduates Only

Rural Soc. 631. Population Analysis. 0-0-5

Prerequisites: Rural Sociology 411, 551, 552.

Sources and characteristics of population data, problems in population data analysis, and a critical survey of important analytical studies and periodicals in the field.

Mr. Hamilton.

Rural Soc. 632. The Rural Family. 0-3-0

Historical forms and functions of rural family life; family activities and relationships; stages of family growth; the family-sized farm; effects of technical and economic changes on rural family; national policies.

Mr. Green.

Rural Soc. 633. The Rural Community. 0-0-3

Human ecology; types of communities; historical trends; economic, cultural and psychological factors; solidarity and disorganization; special interest groups; service agencies; state and national relations; "Utopian" experiments; planning.

Mr. Mayo.

Rural Soc. 641. Research in Rural Sociology. Credits by arrangement

Objectives of research; the scientific method; planning; organization, and direction of rural studies; preparation of schedules, interviewing, editing, tabulation, and analysis; field experience; preparation of research reports.

A maximum of nine credits is allowed toward the Master's degree, but any number toward the Doctorate.

Staff.

Rural Soc. 652. Comparative Rural Societies. 0-3-0

Sociological analysis of rural societies around the world with particular reference to North and South America. In these societies special emphasis is given to their cultural and physical setting, population composition, levels of living, relations of the people to the land, structure and function of the major institutions, and forces making for change.

Mr. Mayo.

Rural Soc. 653. Theory and Development of Rural Sociology. 0-0-3

History of the field; theories and contributions of leading sociologists; critical review of current literature; preparation of outlines on specific subjects.

Mr. Hamilton.

Rural Soc. 663. Social Aspects of Agricultural Programs. 0-0-3

The study of agricultural programs as implemented by organizations in dynamic relation with the people whom they serve. The course considers the relation of agricultural programs to the social structure and forces in rural society, the problems of coordinating different types of programs, the problem of professional leadership, and problems of stimulating local leadership and participation.

Mr. Lowry.

Rural Soc. 671. Seminar. Credits by arrangement

Review of current publications; student research papers; progress reports of departmental research; discussion of research methods and plans; reports from scientific meetings and conferences.

A maximum of three credits is allowed toward the Master's degree, but any number toward the Doctorate.

Staff.

DEPARTMENT OF SOCIOLOGY

Graduate Faculty

Professor: SANFORD RICHARD WINSTON.

No program leading to graduate degrees are offered in sociology as such at State College. The course of work listed below is acceptable for graduate credit as part of a program in some other area of graduate study.

Courses for Advanced Undergraduates

Soc. 412. Introduction to the Field of Social Work. 3 credits

Prerequisite: Soc. 202 and permission of the instructor.

An introductory course, designed to acquaint students with the various types of public and private social work and with remedial and preventive programs in relation to applied sociology, social psychiatry, health, welfare and recreation.

Staff.

Soc. 401. Social Pathology. 3 credits

Prerequisite: Soc. 202, supplemented by credits in related fields.

Pathological problems arising from social life; social and individual adjustments.

Messrs. Winston, Johnson.

Soc. 402. Sociology of City Life. 3 credits

Prerequisites: Soc. 202 or Soc. 343, supplemented by credits in related fields.

Elective.

Problems arising from growth of modern town and city life; city planning in regard to social and industrial progress.

Messrs. Winston, Johnson.

Soc. 404. Educational Sociology. 3 credits

Prerequisite: nine term credits in the Social Sciences.

Application of the principles of Sociology to the practical problems of education with emphasis placed on the relation between adjustment processes in the school and in the larger social world.

Mr. Winston.

Soc. 410. Industrial Sociology. 3 credits

Prerequisite: Soc. 202, supplemented by credits in related fields.

Influence of industrial life; occupations as social and industrial factors; problems arising from our industrial era.

Messrs. Winston, Johnson.

Soc. 421. American Community Relationships. 3 credits

Prerequisite: Nine term credits in Sociology, including Soc. 202.

A survey of the institutions, organizations, and agencies to be found in the modern American community, the social conditions or problems, such as recreation, health, welfare, etc. with which they deal; their inter-relationships and the trend toward overall planning.

Mr. Rawls.

Courses for Graduate and Advanced Undergraduates

Soc. 501. Leadership. 3 credits

Prerequisite: nine term credits in Sociology, including Sociology 202.

A study of leadership in various fields of American life: analysis of the various factors, inherent or acquired, that are associated with leadership, past and present. Mr. Winston.

Soc. 502. Juvenile Delinquency. 3 credits

Prerequisite: Soc. 202, supplemented by credits in related fields.

Analysis of the factors which produce antisocial and delinquent behavior, followed by a study of the various methods of treatment, with emphasis on prevention. Mr. Winston.

Soc. 503. American Culture. 3 credits

Prerequisites: Soc. 202 or Soc. 210, supplemented by credits in related fields.

Analysis of present-day culture, with particular reference to the United States and its regional variations. Mr. Winston.

Soc. 504. The American People. 3 credits

Prerequisite: Soc. 202, supplemented by credits in related fields.

Analysis of crucial problems connected with the growth and decline of populations in the United States; factors connected with birth and death rates; marriage rates; discussion of the changing quality of population groups. Messrs. Winston, Johnson.

Soc. 515, 516, 517. Research in Applied Sociology. 3-3-3

Prerequisite: nine term credits in Sociology, and permission of the instructor.

Individual research problems in applied fields of sociology, such as problems of the family, of population, of social work rural-urban relations; student success; American leadership; social aspects of recreation. Staff.

DEPARTMENT OF STATISTICS (EXPERIMENTAL)

Graduate Faculty

Professors: JACKSON ASHCRAFT RIGNEY, Head, RICHARD LOREE ANDERSON, RALPH ERNEST COMSTOCK, GERTRUDE MARY COX, HENRY LAURENCE LUCAS, HAROLD ROBINSON, HUGH FAIRFIELD SMITH.

Associate Professors: ALVA LEROY FINKNER, ROBERT JOHN HADER, ROBERT JAMES MONROE.*

Assistant Professor: FRANCIS EDWARD MCVAY.

The Department of Experimental Statistics offers the Master of Science and the Doctor of Philosophy degrees.

The department provides statistical consultant and computing service to the Agricultural Experiment Station and to other research departments on the campus and in the State. It provides several federal agencies with research and consulting service on a contract basis. All of this work provides a wealth of "live" problems on which graduate students acquire experience and maturity.

* Resigned 1952.

A fully equipped IBM laboratory is maintained for research requiring excessive computations, and automatic desk calculators are available for smaller jobs.

The department maintains close liaison with the Department of Mathematical Statistics at the University in order to strengthen the offerings in statistical theory and mathematics.

All fields of research are becoming aware of the necessity for statistical consultation in the design of experiments and in extracting information from resulting data. This has created an unprecedented demand for consultants and teachers in experimental statistics. This demand is equally strong from Universities, Agricultural Experiment Stations, National Defense Agencies, other federal research agencies and industrial research groups. At present there are so few institutions that are providing this type of training that there is no hope of satisfying the demand for years to come.

Courses for Graduates and Advanced Undergraduates

Stat. 512. Basic Experimental Statistics. 4 or 4-0

Prerequisites: Stat. 311 and one term of college mathematics, or consent of instructor.

Basic concepts of statistical models and use of samples; variability in sample data; distributions; estimation of parameters; simple test of significance: t-test, analysis of variance, chi-square tests.

Messrs. Robinson, Lucas.

Stat. 513. Experimental Statistics for Biological Sciences. 0-4 or 4

Prerequisite: Stat. 512.

Extension of basic concepts to biological experiments; computing techniques, more complicated analyses such as covariance, multiple regression, multiple covariance, analysis of variance with multiple classifications; computation and application of single degrees of freedom. Mr. Monroe.

Stat. 521. Applied Mathematical Statistics I. 4-0-0

Prerequisite: Undergraduate calculus.

Probability, frequency distribution, moments, sampling distributions.

Mr. Smith.

Stat. 522. Applied Mathematical Statistics II. 0-4-0

Prerequisite: Stat. 521.

General theory of estimation and tests of significance, non-parametric tests.

Mr. Smith.

Stat. 523. Applied Mathematical Statistics III. 0-0-4

Prerequisite: Stat. 522.

Least squares—multiple regression, analysis of variance and covariance, and variance components.

Mr. Smith.

Stat. 531. Design of Experiments. 3-0 or 3

Prerequisites: Stat. 513 or Stat. 523 or Stat. 543.

Fundamental principles of designs; randomized blocks and Latin squares; treatment components; experimental and sampling errors, components or error, confounding; factorial, split-plot, and incomplete block designs.

Mr. Anderson.

Stat. 532. Sample Survey Designs. 0-3-0

Prerequisite: Stat. 311.

Description of survey designs involving simple random, stratified and systematic samples; subsampling, quota, list and area sampling; expansion factors; sampling errors in a finite population. Discussion of designs for specific surveys.

Mr. Finkner.

Stat. 543. Experimental Statistics for Social Sciences. 0-0-4

Prerequisite: Stat. 512.

Extension of basic concepts to social experiments; use of index numbers; contingency tables; multiple regression and analysis of variance for time series data; orthogonal polynomials.

Mr. McVay.

Stat. 551, 552. Statistical Analysis of Social Data. 3-3-0

Applications of statistical theory to special problems in sociological research.

Mr. Hamilton.

Stat. 561, 562, 563. Experimental Statistics for Engineers. 3-3-3

Prerequisite: Stat. 361. Probability and Calculus are desirable.

Methods for the interpretation of data in engineering and the physical sciences. Applications of the theory of errors to experimental data, standard tests of significance, essentials of the theory of estimation, and analysis of variance and covariance, with an introduction to correlation and regression. Introduction to the efficient design of experiments.

Mr. Hader.

Courses for Graduates Only

Stat. 611, 612, 613. Special Problems. 1-3, 1-3, 1-3

Development of techniques for specialized cases, particularly in connection with thesis problems.

Staff.

Stat. 615. Research Methods in Plant Science. 3-0-0

Prerequisite: Stat. 513.

Techniques of establishing and maintaining field and greenhouse experiments, size, shape and orientation of plots, border effects, estimation of experimental material required for specified accuracy, subsampling plots and yields for laboratory analyses.

Mr. Rigney.

Stat. 621. Statistics in Animal Science. 0-0-3

Prerequisite: Stat. 512 or Stat. 522.

Co-requisite: Stat. 513 unless have had Stat. 522.

Sources and magnitudes of errors in experiments with animals, experimental designs adapted for specific types of animal research, amount of data required for specified accuracy, factors involved in the increase of accuracy at minimum cost.

Mr. Lucas.

Stat. 625, 626. Statistical Concepts in Genetics. 0-3-3

(626 in alternate years, not to be offered in 1953)

Prerequisites: Stat. 512 or Stat. 522 and Genetics 512 unless taken concurrently.

The composition of phenotypic variance and the estimation of environmental, genetic, and heritable genetic variance. The effects of various selection procedures and systems of breeding on population means and variances.

Mr. Comstock.

Stat. 631. Theory of Sampling Applied to Survey Design. 0-0-3

Prerequisite: Stat. 513 or Stat. 523.

Basic theory of sampling from a finite population. Confidence limits and estimation of optimum sample size. Comparison of simple random, stratified, quota, purposive, and systematic sample. Choice of sampling unit. Subsampling. Relative efficiencies of different methods of estimation. Double sampling. Discussion of unique applications of sampling theory.

Mr. Finkner.

Stat. 642. Advanced Design of Experiments. 0-3-0

Prerequisites: Stat. 531 and Stat. 523.

Construction and use of designs—confounding, quasi-factorial, incomplete blocks and lattice square designs, methods of analysis. Survey of types of designs available. Long time and groups of experiments.

Miss Cox.

Stat. 645, 646, 647. Advanced Experimental Statistics for Engineers. 3-3-3

Prerequisites: Stat. 563, advanced calculus, Matrix Algebra (Calculus or matrix algebra may be taken concurrently).

Extension of courses Stat. 561-2-3 to include methods applicable to exceptional cases, and to the design of complex experiments. Study of assumptions underlying statistical techniques, and consequences when assumptions are not satisfied. Recent results.

Stat. 651. Statistical Techniques in Agricultural Economics. 3-0-0

Prerequisite: Stat. 543 or Stat. 523.

Analysis of variance with disproportionate frequencies; variance components; designing experiments or surveys to estimate relationships; introduction to multi-equation regression methods.

Mr. Anderson.

Stat. 652, 653. Econometric Methods. 0-3-3

Prerequisites: Stat. 651 and Stat. 523.

Formulation of econometric models; estimation of parameters; multivariate analysis; multi-equation methods; linear programming; time series analysis; serial correlation.

Mr. Anderson.

Stat. 661, 662. Applied Multivariate Analysis. 4-4-0

Prerequisites: Stat. 513 (Also analytic geometry and the elementary properties of determinants).

The general multivariate model for experimental work, relations between multiple regression, analysis of variance and multivariate analysis, factor analysis, the generalized variance, the generalized Student ratio, intra-class correlations, testing compound symmetry between two sample covariance matrices, scale analysis, canonical correlation, testing for the rank of a correlation matrix.

Mr. Nicholson.

Stat. 663. Special Problems in Multivariate Analysis. 0-(3 or 5)-0

Prerequisite: Stat. 661 or Permission of Instructor.

A seminar course devoted to special problems in applied multivariate analysis particularly designed for advancing the use of methods in specific research problems.

Staff.

Stat. 664. Psychological Aspects of Factor Analysis. 0-0-4

Prerequisite: Stat. 661 or Permission of Instructor.

History of factor analysis, theory of two-factors, fictitious factors, heirarchical order, need of group factors, the centroid method, communalities,

common factor space estimation of factors, orthogonal and oblique factors, the problem of rotation, simple structure, second order factors.

Mr. Thurstone.

Stat. 675, 676. Advanced Experimental Statistics.

3-3-0

Prerequisite: Stat. 523.

Regression analysis with errors in both variates; orthogonal polynomials; principles of constructing experimental models; effects of inadequacies in the models; variance components; discriminant functions; uses of chi-square; methods of combining data with heterogeneous errors; methods of transforming data to meet specific objectives.

Mr. Anderson.

Stat. 681. Seminar.

1-1-1

A maximum of three credits is allowed toward the Master's degree, but any number toward the Doctorate.

Staff.

Stat. 691. Research.

Credits by arrangement

A maximum of nine credits is allowed toward the Master's degree; no limitation on credits in Doctorate programs.

Staff.

SCHOOL OF TEXTILES

Professors: MALCOLM EUGENE CAMPBELL, Dean, CLARENCE MONROE ASBILL, JR., JOHN FRANCIS BOGDAN, KENNETH STODDARD CAMPBELL, ELLIOTT BROWN GROVER, THOMAS ROY HART, HENRY AMES RUTHERFORD, WILLIAM EDWARD SHINN, and BENJAMIN LINCOLN WHITTIER.

Associate Professor: DAME SCOTT HAMBY, ARTHUR COURTNEY HAYES.

Visiting Associate Professor: IVAN YEN-TA FENG.

The School of Textiles offers two graduate degrees: Master of Science in Textile Manufacturing and Master of Science in Textile Chemistry. The graduate student in Textile Manufacturing may carry on his major work in one of the following fields: Yarn Manufacturing, Knitting, Synthetics, or Weaving and Designing.

An applicant for admission to the Graduate School for work in Textiles must possess a Bachelor of Science degree in Textiles or its equivalent, in addition to satisfying the general requirements for admission.

The physical resources of the School of Textiles are at the disposal of our graduate students. Separate research laboratories for both physical and chemical investigations are provided for the exclusive use of graduate students and the specialized equipment of the Textile Research Department also is available for graduate research. The textile equipment and testing instruments available at the School of Textiles are of such quality and variety that almost any type of textile problem can be investigated thoroughly. A large, and representative textile library is one of the important facilities available for graduate study.

The unprecedented development of synthetic fibers currently underway has opened a tremendous field for the textile scientist and technologist. Fiber producers clamor for men trained to conduct the systematic investigations which lead to product development and improvement.

Courses for Advanced Undergraduates

Tex. 404, 405. Synthetic Fiber Processing.

3-3-0 or 0-3-3

Prerequisites: Tex. 307, 308.

Required of seniors in Yarn Manufacturing and Synthetic Options.

Elective for others.

Studies of the contributions of individual fibers to the entire blend covering both the man-made as well as natural fibers. Processing of man-made fibers into spun yarn and fabric, particularly on the cotton system. The processing of man-made fibers by new methods, such as by direct spinning and the Pacific Converter. Studies of the modification of machines for processing synthetic fibers alone or in blend with other fibers.

Messrs. Grover, Hamby.

Tex. 407, 408. Yarn Manufacture IV.

3-3-0

Prerequisites: Tex. 307, 308.

Required of seniors in Yarn Manufacturing and General Textiles Options. Elective for others.

Co-ordinated studies of the manufacture of yarn in the classroom and laboratory. Machine layout and sequence, draft limits, modern machines and processes, labor requirements, speeds, productions, and special related aspects are all combined to give an overall knowledge of yarn manufacture. Laboratory exercises involve processing from bale to packaged yarn.

Mr. Hilton.

Tex. 411, 412. Testing and Quality Control.

4-4-0

Prerequisite: Tex. 316.

Required of students in Quality Control Option. Elective for others.

Fiber, yarn, and fabric testing on natural and man-made fibers with special emphasis on cotton and wool, and man-made fibers in current production. A study of advanced testing techniques for staple and filament yarns and fabrics, including quality control programs such as "defect preventative" methods and pin-pointing of trouble. Technical report writing, library work, and relationship between a quality control department and operating divisions. Study of Military Specifications and U. S. Government Standards such as CCC-T191b. Attendance at technical meetings, such as The Fiber Society, A.S.T.M. A.S.Q.C., etc.

Messrs. Grover, Hamby.

Tex. 414, 415. Development Project.

0-2-2

Prerequisite: Tex. 411.

Required of students in Quality Control Option.

Studies are conducted independently on assigned problems, and seminars are held on applications and administration of testing, quality control, and development. Studies and discussion of budgeting and evaluation of priority and progress. Current technical developments are discussed. Results of project to be written in form of a technical report from a control and development laboratory.

Staff.

Tex. 416. Wool Manufacture I.

3 or 3 or 3

Prerequisites: Tex. 206, 207.

Required of Seniors in Yarn Manufacturing and Synthetics Options. Elective for others.

Raw materials used in wool and worsted trades; classification, structure, and characteristics of fibers, grading, sorting and mixing. Reclaimed wool and secondary raw materials. Lectures are supplemented by laboratory applications.

Mr. Hilton.

Tex. 420. Fiber Quality I.

0-3-0

Required of juniors in Textiles and Textile Chemistry.

History, development, production, ginning and handling of cotton. World crops; marketing methods; classification; relation of grade and staple to the value of cotton. Measurement of the physical properties of cotton fibers and their relation to spinning quality; relation to grade and staple to waste, spinning behavior, and yarn quality. Selection of cotton for different types of yarns and fabrics.

Mr. Campbell.

Tex. 421. Fiber Quality II.

3-0-0 or 0-0-3

Required of juniors in Textiles.

An introduction to synthetic fiber knowledge, including the history, development, and classification of all synthetic fibers. A study of the manufacturing processes of synthetic yarns. A description of the chemical and physical properties of the fibers and yarns and how these affect the selection of synthetic yarns and fabrics by consumers.

Messrs. Rutherford, Whittier.

Tex. 424. Yarn Technology.

0-3-0 or 0-0-3

Prerequisites: Tex. 307, 308.

Required of seniors in Yarn Manufacturing and Synthetics Options. Elective for others.

A summary of the calculations involved in the production of yarn. The effect of staple, quality, twist, and fiber size and distribution on yarn characteristics. Novelty yarns. The technological aspects of blending different synthetics together or with natural fibers. Production of sewing thread.

Mr. Hilton.

Tex. 426, 427. Mill Organization.

0-3-3

Prerequisites: Tex. 307, 308; Tex. 341, 342.

Required of seniors in Textiles.

Studies of organizations of textile mills from personnel as well as functional viewpoints and of the planning and scheduling of manufacturing contracts through opening and weaving mills. Analysis of manufacturing organizations based on processes and equipment.

Mr. Grover.

2 or 2-0

Tex. 437. Weaving Laboratory IV.

Prerequisites: Tex. 335, 336.

Required of seniors in General Textiles and Weaving and Designing Options. Elective for others.

Operation and fixing of dobby, pick and pick, and jacquard looms; preparation of warps to weave rayon, wool and fine cotton fabrics; building of box, dobby and multiplier chains.

Mr. Moser.

Tex. 438. Weaving Laboratory V.

0-2-0 or 0-0-2

Prerequisites: Tex. 335, 336.

Required of seniors in Weaving and Designing Option.

Continuation of Tex. 437 with special emphasis upon making original designs for dobby fabrics, preparing the warps and weaving the fabrics.

Mr. Moser.

Tex. 439. Pile Fabrics.

0-0-3

Prerequisite: Tex. 437.

Elective.

A study of single shuttle and double shuttle pile fabric such as terry cloth, corduroy, plush, and carpet fabrics. This will include the fabric structure, yarn preparation, weaving, and finishing aspects of pile fabrics woven on cam, dobby, and jacquard looms.

Mr. Berry.

Tex. 443. Dobby Design II.

3-0-0

Prerequisite: Tex. 341.

Required of seniors in General Textiles and Weaving and Designing Options. Elective for others.

A detailed study of the design and weave of complicated fabrics such as double cloth, corduroy, velveteen, crepe and intricate figured designs, matelasse, velvet and frieze.

Mr. Porter.

0-3-0

Tex. 445. Jacquard Design.

Prerequisite: Tex. 341.

Required of seniors in Weaving and Designing Option. Elective for others.

Designing fancy and jacquard fabrics; methods of making original designs for table napkins, table cloths, dress goods, draperies.

Mr. Berry.

Tex. 451. Fabric Analysis II.

2-0-0

Prerequisite: Tex. 342.

Required of seniors in General Textiles and Weaving and Designing Options. Elective for others.

Analyzing samples of cotton, wool, worsted, linen, rayon, and silk fabrics for size of yarns, ends and picks per inch, weight of warp and filling, so as to reproduce accurately samples analyzed; obtaining design, drawing in draft, chain, and reed plan for fancy fabrics, such as stripes, checks, extra warp and extra filling figures, leno fabrics, jacquard fabrics, draperies.

Staff.

Tex. 452. Fabric Characteristics.

0-3 or 3

Prerequisite: Tex. 341, 342.

Elective.

A study of the identification, classification, and utilization of woven fabrics and how these are affected by various properties such as geometry, weave, and finish. Actual inspection of a wide range of fabrics with emphasis on a study of defects and their influence on quality will be included in the laboratory work.

Mr. Whittier.

Tex. 455. Color in Woven Design.

3 or 3 or 3

Prerequisite: Tex. 341.

Required of seniors in Weaving and Designing Option. Elective for others.

Pigment and light theories of color; contrast and harmony of colors; factors which influence quality, style, and color; methods of applying weaves and color to fabrics for wearing apparel and home decorations.

Mr. Hart.

Tex. 460. Knitting Mechanics.

0-3-0

Prerequisites: Tex. 261, 269.

Mathematics and mechanics of flat and rib knitting.

Inter-relation of yarn number, yarn diameter, gauge, cut, stitch, length, fabric structure, and weight; proportions of yarn in multiple-thread work; production problems, etc.

Mr. Shinn.

Tex. 463, 464, 465. Knitting Garment Laboratory.

2-2-2

Prerequisites: Tex. 261, 269.

Required of students in Knitting Option. Elective for others.

A study of circular latch needle and spring needle machines for knit fabric production; styling, cutting and seaming of the basic garment types for underwear and outerwear; standard seam types; high-speed sewing machines.

Messrs. Shinn, Lewis.

Tex. 468. Flat Knitting.

3-0-0

Prerequisites: Tex. 261, 269.

Required of seniors in Knitting Option. Elective for others.

A study of the leading types of flat knitting machines including warp knitting machines, design possibilities, and fabric adaptability.

Mr. Shinn.

Tex. 469. Tricot Knitting.

0-0-3

Prerequisites: Tex. 261, 269.

Required of seniors in Knitting Option. Elective for others.

A study of basic types of tricot knitting machines with emphasis on mechanisms and fabrics. Attention is given to warp preparation methods applicable to the tricot machine, the characteristics of yarns made from natural and synthetic fibers as they affect processing into warp knitting fabrics, machine settings for proper qualities and ratios; economics of warp knitting, and end uses. Attention is given to fabric design and analysis.

Mr. Shinn.

Tex. 471. Full Fashioned Hosiery Manufacture.

0-0-2

Tex. 473, 474, 475. Knitting Laboratory II.

2-2-2

Prerequisites: Tex. 261, 269.

Required of seniors in Knitting Option. Elective for others.

Mechanics of the full-fashioned hosiery machine including practical training in its adjustment and operation. Attention is given to yarn preparation, knitting, inspection, finishing and packaging hosiery.

Mr. Shinn.

Tex. 470. Textile Cost Methods.

3 or 3 or 3

Prerequisites: Tex. 307, 308; Tex. 341, 342.

Required of seniors in Textiles except those in Management Option.

A survey of cost methods applicable to textile mills with emphasis on calculations, the preparation of cost reports, and their use in cost control.

Mr. Shinn.

Tex. 477. Hosiery Manufacture.

3 or 3 or 3

Prerequisites: Tex. 261, 269.

Required of seniors in Textiles.

A study of advanced types of circular knitting machines and the problems involved in the manufacture of the more complex types of hosiery. Hosiery design and analysis.

Messrs. Harrill, Shinn.

Tex. 490. Synthetics I.

3 or 3 or 3

Prerequisite: Tex. 421.

Required of students in General Textiles and Yarn Manufacturing Options.

A general course including: textile processing of continuous filament synthetic yarns in the yarn producing plants; preparation of yarns for weaving and knitting including crepe, voile and hosiery yarns; the application of synthetic yarns for use as industrial yarns and fabrics; also calculations involving the denier system and production calculations.

Messrs. Grover, Hamby.

Tex. 491, 492, 493. Synthetics II.

3-3-3

Prerequisite: Tex. 421.

Required of students in Synthetics Option.

Advanced study of synthetic yarn properties and handling methods. Comprehensive study of sized and unsized warp preparation, twisting, weaving, filling yarn preparation, cloth grading, tricot warp preparation, and single end sizing for knitting purposes. Styling and merchandising of synthetic yarn end products.

Messrs. Grover, Hamby, Moser.

Courses for Graduates and Advanced Undergraduates

Tex. 509. Textile Testing II.

0-0-3

Prerequisites: Tex. 316, Stat. 361, or graduate standing.

Required of students in Quality Control Option. Elective for others.

The application, evaluation, and interpretation of textile data with special emphasis on quality control charts, reliability of averages, sampling, etc. Study of advanced techniques in evaluation of staple fiber fabrics, including blend evaluation and analysis. A study of laboratory layout, cost of testing and testing equipment, and organization.

Messrs. Grover, Hamby.

Tex. 515. Yarn Manufacturing Project.

0-0-3

Prerequisites: Tex. 307, 308.

Required of seniors in Yarn Manufacturing Option.

Setting up an assigned project, processing, testing and analysis of results, together with a written report on all phases is required.

Mr. Grover.

Tex. 517. Textile Organization Control.

0-0-3

Prerequisites: Senior standing, Econ. 302, 325, Tex. 426.

Analysis of actual case problems peculiar to the textile industry covering various management aspects such as organization structure, policy determination, wage incentives, training, mill layout, from the standpoint of the top executive.

Mr. Feng.

Tex. 535. Weaving VI.

0-0-3

Prerequisite: Tex. 437.

Required of seniors in Weaving and Designing Option. Elective for others.

Construction of looms, adaptable to weaving the more intricate fabrics of natural and synthetic fibers; pick and pick looms; box and multiplier chain-building; arrangement of colors in boxes to give easy running loom; extra appliances for weaving leno, towel, and other pile fabrics; relative speed of looms; production calculations and fabric costs. Weave room management.

Mr. Whittier and Staff.

Tex. 544. Dobby Design III.

0-3-0

Prerequisite: Tex. 443.

Required of seniors in Weaving and Designing Option. Elective for others.

Combination of plain and fancy weaves with leno; methods of obtaining leno patterns; methods of making original designs for dress goods, draperies, etc.

Mr. Whittier and Staff.

Tex. 546. Jacquard Design and Weaving.

0-0-3

Prerequisite: Tex. 445.

Required of seniors in Weaving and Designing Option. Elective for others.

Construction and operation of single, double lift, and rise and fall jacquards; tie-up of harness for dress goods, table napkins, damask and other jacquard fabrics such as leno; card cutting, lacing; making original jacquard designs.

Mr. Whittier and Staff.

Tex. 599. Instrumentation and Control.

3 or 3 or 3

Required of all seniors in Textiles and Textile Chemistry.

A lecture series with coordinated laboratory exercises designed to familiarize the student with the theory and application of instruments and control apparatus that he will find in the modern textile plant.

The studies cover the measurement and control of temperature, humidity, regain, chemical processes, physical finishing processes, time and temperature cycles, yarn and cloth tension, speed, and fluid pressure. Mr. Asbill.

Courses for Graduates Only

Tex. 601, 602, 603. Yarn Manufacture.

3-3-3

Prerequisites: Tex. 407, 408 or equivalent.

A study of breaking strength and related properties of cotton yarns made under various atmospheric conditions; comparison of yarns produced from long and short-staple cotton with regular and special carding processes; efficiency of various roller covering materials at the drawing processes; elimination of roving processes by special methods of preparation; comparison of regular and long-draft spinning. Messrs. Grover, Hamby.

Tex. 605, 606, 607. Textile Research.

3-3-3

Problems of specific interest to the textile industry will be assigned for study and investigation. The use of experimental methods will be emphasized. Attention will be given to the preparation of reports for publication. The master's thesis may be based upon the data obtained.

Mr. Grover and Staff.

Tex. 609. Textile Testing III.

0-3-0 or 0-0-3

Prerequisite: Tex. 509.

Design of textile laboratories, including conditioning equipment and instruments required for specific needs; performance of tests and analysis of data on industrial problems; specialized physical tests; inter-laboratory tests and analysis; study of A.S.T.M. specifications and work on task groups for the A.S.T.M. Society. Messrs. Grover, Hamby.

Tex. 611. Synthetics IV.

0-0-3

Prerequisites: Tex. 491, 492.

Setting up an assignment project on problems peculiar to the processing of continuous filament yarns, particularly in the initial preparatory stages of processing, and including sizing, twisting, winding, and associated problems. Messrs. Grover, Hamby.

Tex. 631, 632, 633. Textile Design and Weaving.

3-3-3

Prerequisites: Tex. 443, 544, or equivalent.

Study and practice in more advanced designing and analysis of fabrics, such as lenos made with twine and wire doups, lappits, and other fancy fabrics; designing for jacquard dress goods, table covers, reversibles, and other fabrics; making original designs for dobby and jacquard fabrics; fabric costs; weaving fancy and jacquard fabrics.

Mr. Whittier and Staff.

Tex. 635, 636, 637. Seminar.

1-1-1

Discussion of scientific articles of interest to textile industry; review and discussion of student papers and research problems.

Mr. Grover and Staff.

Tex. 661, 662, 663. Knitting Research.

3-3-3

Prerequisites: Graduate standing and 12 credits in knitting.

Problems of specific interest to the knitting industry will be assigned for study and investigation. The use of experimental methods will be emphasized. Attention will be given to the preparation of reports for publication.

Mr. Shinn and Staff.

TEXTILE CHEMISTRY

Courses for Advanced Undergraduates

TC405, 406, 407. Textile Chemistry III.

4-4-4

Prerequisite: TC307.

Required of all students in Textile Chemistry.

A continuation of TC305, 306 and 307 with special emphasis on modern dyeing methods. Laboratory exercises and use of pilot and mill-scale equipment of many types in dyeing all important fibers and fiber mixtures. Selected topics of importance to the textile chemist with special attention to current technological advances in the field. Visits to mills selected to cover a wide variety of processing techniques.

Two 1-hour lectures and one 4-hour laboratory per week.

Mr. Campbell.

TC408. Fabric Finishing I.

3 or 3 or 3

Prerequisite: TC303.

Required of seniors in Synthetics Option. Elective for others.

A brief course in the application of finishes to fabrics. Outlined to meet the needs of general textile students with little emphasis on the chemistry of finishing compounds. Lectures accompanied by demonstrations.

Three 1-hour lectures per week.

Messrs. Rutherford, Davis.

TC409. Fabric Finishing II.

0-0-4

Prerequisite: TC307.

Required of students in Textile Chemistry.

A study of the compounds used in the finishing of fabrics, and of the methods used in laboratory development and plant application of finishing compounds. Studies of the methods of evaluation of finishes are included in the laboratory work.

Two 1-hour lectures and one 4-hour laboratory period per week.

Mr. Rutherford.

TC410. Textile Microscopy.

2 or 2 or 2

Prerequisites: Tex. 420, 421. These courses may be taken concurrently.

Required of all textile students.

Lectures, demonstrations and experiments in the use of the microscope; preparation of slides; fiber identification; examination of yarns and fabrics. Fundamentals and applications of the polarizing microscope. Photomicrography. Micrometry. Phase and electron microscopy.

Two 2-hour laboratory periods per week.

Mr. Davis.

TC411. Textile Chemical Analysis A.

3-0-0

Prerequisites: Chem. 212, TC307.

Elective for students in Textile Chemistry.

Analysis of known textile chemicals and related materials such as water, soap, wetting agents, synthetics detergents, bleaching and stripping agents, and finishing compounds.

Messrs. Rutherford, Campbell, Davis.

TC412. Textile Chemical Analysis B.

0-3-0

Prerequisites: Chem. 212, TC307.

Elective for students in Textile Chemistry.

Identification and quantitative determination of materials employed in several broad categories of textile wet processing such as sizes, surface active agents, dyestuffs and finishes.

Messrs. Rutherford, Campbell, Davis.

TC413. Textile Chemical Analysis C.

0-0-3

Prerequisites: Chem. 212, TC307.

Elective for students in Textile Chemistry.

Analysis of textile materials involving specialized instruments and techniques such as spectrophotometry, flame photometry, surface tension measurements, pH measurements, electrometric titration, viscometry, etc.

Messrs. Rutherford, Campbell, Davis.



Effect of Twist on Physical Property of Nylon Yarn is Studied on
Modified Inclined-Plane Tensile Testing Machine
in the School of Textiles.

TC414, 415. Textile Printing.

0-3-3

Prerequisite: TC307.

Required of students in Textile Chemistry.

Fundamentals of textile printing with major emphasis on modern roller printing methods; design of printing machines, preparation of cloth for printing, formulation and properties of printing pastes, application techniques for all important types of dyestuff, styles of printing, and ageing and aftertreating procedures.

Mr. Campbell.

One 1-hour lecture and one 4-hour laboratory period per week.

Courses for Graduates and Advanced Undergraduates**TC510. Advanced Textile Microscopy.**

3 or 3 or 3

Prerequisite: TC410.

Elective.

Study of textile starches, fibers, fabrics. Preparation of permanent slides. Study of various mounting media; methods of cross-sectioning; reagents and stains. Applications of the polarizing microscopy. Photomicrography. Industrial Microscopy, Phase and Electron Microscopy.

Mr. Rutherford and Staff.

TC520, 521. Chemistry of Fibers.

3-3-0

Prerequisite: TC307 or Chem. 423.

Required of students in Textile Chemistry.

A lecture course emphasizing: the theory of fiber structure; the relationship between the chemical structure and physical properties of fibers; the nature of the chemical reactions which produce degradation of fibers; the production of synthetic fibers. TC520 is devoted to the chemistry of the cellulosic fibers, both natural and regenerated. TC521 deals with the protein fibers and the true synthetics. TC520 is not a prerequisite for TC521 nor vice versa. Students outside of the field of Textile Chemistry who may possibly have a choice of either course should take TC520 in preference to TC521.

Three 1-hour lectures per week.

Mr. Rutherford.

TC530. Chemical Testing of Textiles.

3 or 3 or 3

Prerequisites: TC303 and Tex. 421.

An elective course for all students in Textile except those majoring in Textile Chemistry.

The work includes the chemical identification of fibers, the qualitative and quantitative analysis of fiber blends by chemical means, and the evaluation techniques for dyed and finished materials.

One 1-hour lecture and two 2-hour laboratories per week.

Messrs. Rutherford, Campbell.

TC532. Seminar in Textile Chemistry.

0-0-2

Prerequisite: TC405.

Elective for Textile Chemistry students.

The course is designed to familiarize the student with the principal sources of textile chemical literature and to emphasize the importance of keeping abreast of developments in the field of textile chemistry. Particular attention is paid to the fundamentals of technical writing. Reports.

Mr. Campbell, Staff.

Courses for Graduates Only

TC605, 606, 607. Textile Dyeing.

3-3-3

Prerequisite: TC407.

The course consists of matching shades from standard and season color cards upon classes of materials which require skill in their dyeing, such as three-fiber, cotton-wool, and half-silk hosiery, woolens and worsteds with effect stripes, and cotton fabrics with woven figures or stripes of the different varieties of rayon; advanced work on chemical examination of materials used in dyeing and finishing. Theories of dyeing and finishing are also included.

Mr. Campbell, Staff.

ZOOLOGY

A UNIT OF THE DIVISION OF BIOLOGICAL SCIENCES

Graduate Faculty.

Professors: FREDERICK SCHENCK BARKALOW, JR., Head, BARTHOLOMEW BRANDNER BRANDT, REINARD HARKEMA, ZENO PAYNE METCALF.

Associate Professors: JOHN LAWRENCE EVERS, THOMAS LAVELLE QUAY.

The Master of Science and the Doctor of Philosophy degrees are offered in Animal Ecology and Wildlife Conservation and Management. Graduate programs leading to advanced degrees in Animal Parasitology can be arranged in cooperation with the Department of Zoology of the University of North Carolina at Chapel Hill.

The new O. Max Gardner Biological Laboratories building has excellent facilities for training and research. The classrooms and laboratories are furnished with modern equipment. Excellent graduate student offices are available as well as a number of well-equipped research laboratories which provide space for graduate students' investigations. Excellent library facilities are provided for advanced study in the special areas of Zoology in which graduate degrees are offered.

Accommodations are provided for the well-curated teaching collections of fish, reptiles and amphibians. An advanced herpetological teaching and research laboratory is located near the range room and the graduate students' offices. A large bird and mammal range adequate to contain an estimated 25,000 specimens is on the same floor as the wildlife teaching laboratory. A separate cataloging and graduate workroom adjoins the bird and mammal range. Comparison collections are available for food habits research studies on all native game animals.

Excellent facilities for life history and ecologic studies are available in the field of animal parasitology. A large autopsy and specimen preparation laboratory is housed in an adjacent building, which also includes an aquarium room, small mammal room, and dermestid room.

Several farm ponds ranging in size from two to seven acres are located on the state lands near Raleigh and are available for farm pond research studies.

A wide variety of positions are open to students holding advanced degrees in Animal Ecology and Wildlife Conservation and Management. There is particular need for young men with training in parasitology and related subjects. While the various state game and fish departments, United States

Fish and Wildlife Service, United States Forest Service, United States Soil Conservation Service, United States National Parks Service, and other state and land use departments employ the majority of graduates, an increasing number of teaching positions in these fields are available. There are, moreover, more vacancies currently available for qualified individuals than can be adequately filled. It appears that this condition will prevail for at least several more years.

Courses for Advanced Undergraduates

Zool. 452. Animal Microtechnique.

0-0-3

Prerequisites: Zool. 101, 102; Chem. 203.

The theory and practice of preparing temporary and permanent mounts for microscopic study.
Mr. Harkema.

Courses for Graduates and Advanced Undergraduates

Zool. 513. Advanced Animal Physiology I.

3-0-0

Prerequisite: Zool. 301.

Fundamentals of animal physiology from an advanced point of view.
Lectures, reading, term report.
Mr. Evers.

Zool. 514. Advanced Animal Physiology II.

0-3-0

Prerequisite: Zool. 513.

Selected fundamental principles in physiology will be studied and interpreted for their relations to the vertebrates. Lectures and critical reports to promote acquaintance with general literature and recent advances.
Mr. Evers.

Zool. 521. Limnology.

4-0-0

Prerequisites: Zool. 102, Bot. 102.

The ecology and productivity of inland waters. Collection, preservation, and identification of the aquatic animal life of North Carolina lakes, ponds, and streams.
Mr. Quay.

Zool. 523. Animal Ecology.

0-0-5

Prerequisites: Zool. 101, 102.

The relations of animals to each other and to their environment, with emphasis on general principles and including practice in methods of studying populations and communities.
Mr. Quay.

Zool. 532. Biological Effects of Radiations.

0-3-0

Prerequisites: Zool. 101 and approval of the instructor.

Recommended Correlatives: Gen. 411, Zool. 301, Bot. 421.

Qualitative and quantitative effects of radiations (other than the visible spectrum) on biological systems; to include both morphological and physiological aspects in a consideration of genetics, cytology, histology, and morphogenesis.
Mr. Grosch.

Zool. 541, 543. Systematic Zoology.

3-0-3

Prerequisites: Zool. 101, 102.

The classification and ecology of selected groups of fishes, amphibians, and reptiles.
Mr. Brandt.

- Zool. 544. Mammalogy.** 0-0-3
Prerequisites: Zool. 101, 102.
The classification and ecology of the major groups of mammals with particular emphasis on those native to the Southeastern United States.
Mr. Barkalow.
- *Zool. 545. Histology.** 5-0-0
Prerequisites: Zool. 101, 102, 223.
The microscopic anatomy of animal tissues. Mr. Harkema.
- Zool. 551, 552, 553. Wildlife Management.** 3-3-3
Prerequisites: Zool. 251, 252, 253; Bot. 541.
The fundamental principles of Wildlife Management are studied in the field and laboratory. Three field trips are taken during the year.
Mr. Barkalow.
- Zool. 561. Animal Embryology.** 5-0-0
Prerequisites: Zool. 101, 102.
The study of fundamental principles which apply in the achievement of complex animal structure including both invertebrate and vertebrate materials. Correlative laboratory study to provide training in the basic disciplines and techniques. This course is intended for advanced students in entomology, animal industry, poultry science, and zoology. Mr. Harkema.
- Zool. 571. Advanced Wildlife Management—Special Studies.**
Credits by arrangement
Prerequisites: Zool. 551, or Zool. 312.
Directed individual investigation of a particular problem, accompanied by an advanced survey of literature. A maximum of six credits allowed toward the Master's degree and nine credits toward the Doctorate.
Messrs. Barkalow, Brandt.
- Zool. 582. Wildlife Food Habits.** 0-3-0
Prerequisites: Botany 101; Zool. 101, 102.
A general survey of the foods and feeding habits of fish, amphibians, reptiles, birds, and mammals, with laboratory practice in methods of conducting food habits studies.
Mr. Quay.
- Zool. 583. Advanced Food Habits Problems.** 0-0-3
Selected problem dealing with the foods and feeding habits of one species of wild animal or a group of similar animals. Messrs. Barkalow, Quay.
- Zool. 591, 592. Parasitology I, II.** 3-3-0
Prerequisites: Zool. 101, 102, 223.
The study of the morphology, biology, and control of the parasitic protozoa and helminths of man, domestic and wild animals. Mr. Harkema.
- Zool. 593. Parasitology III. Medical Entomology.** 0-0-3
Prerequisite: Permission of the instructor.
A study of the morphology, biology, and control of the parasitic arthropods of man, domestic and wild animals. Mr. Harkema.

* Will not be offered in 1953.

Courses for Graduates Only

Zool 603. Advanced Parasitology.

0-0-4

Prerequisites: Zool. 591, Zool. 592.

The study of the theoretical and practical aspects of parasitism; taxonomy, physiology, and immunology of animal parasites. Lectures, conferences, literature and laboratory work.

Mr. Harkema.

Zool. 611. Animal Ecology—Special Studies.

Credits by arrangement

Prerequisites: Zool. 521 or Zool. 523.

Directed individual investigation of a particular problem, accompanied by an advanced survey of literature. A maximum of three credits allowed toward the Master's degree, and nine credits toward the Doctorate.

Mr. Quay.

Zool. 622. Seminar.

One credit per term

Prerequisite: Graduate Standing.

A maximum of three credits is allowed toward the Master's Degree, but any number toward the Doctorate.

Staff.

Zool. 627, 628, 629. Zoogeography.

3-3-3

Prerequisite: Zool. 523.

Animal geography and the factors which influence the distribution of animals.

Mr. Metcalf.

Zool. 641. Research in Zoology.

Credits by arrangement

Prerequisites: Eighteen term credits in Zoology; consent of instructor.

Problems in development, life history, morphology, physiology, ecology, game management, taxonomy, or parasitology.

A maximum of nine credits is allowed toward the Master's degree, but any number toward the Doctorate.

Staff.

CLASSIFICATION OF GRADUATE STUDENTS

Curriculum	Number
AGRICULTURE	
Agricultural Economics	12
Agricultural Engineering	4
Agricultural and Biological Chemistry	8
Agronomy	40
Animal Ecology	4
Animal Industry	21
Botany	2
Dairy Manufacturing	10
Entomology	10
Experimental Statistics	22
Genetics	1
Horticulture	6
Plant Ecology	1
Plant Pathology	9
Plant Physiology	1
Poultry Science	1
Rural Sociology	5
Wildlife Conservation and Management	0
Total	157
EDUCATION	
Agricultural Education	35
Industrial Arts Education	8
Industrial Education	3
Industrial Psychology	21
Occupational Information and Guidance	4
Total	71
ENGINEERING	
Ceramic	7
Chemical	19
Civil	7
Diesel	8
Electrical	14
Engineering Mathematics	5
Engineering Mechanics	1
Engineering Physics	10
Geological	4
Industrial	2
Mechanical	3
Nuclear	31
Total	111
FORESTRY	
Forestry	10
Wood Technology	14
Total	14
TEXTILES	
Textile Chemistry	5
Textile Manufacturing	8
Total	13
Unclassified Graduate Students	55
Grand Total	421

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